Appendix J

Haile Gold Mine EIS
Supporting Information and Analysis
for Surface Water Resources

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List of Acronyms

μg/L	microgram(s) per liter
μm	micrometer(s)
AERMET	atmospheric data generation tool
$CaCO_3$	calcium carbonate
CCC	criterion continuous concentration
cfs	cubic feet per second
CMC	criterion maximum concentration
DO	dissolved oxygen
EIS	Environmental Impact Statement
ERC	Ecological Resource Consultants, Inc.
gpm	gallon(s) per minute
Haile	Haile Gold Mine, Inc.
HDPE	high-density polyethylene
m/s	meter(s) per second
mg/L	milligram(s) per liter
NH_3	nitrogen
NTU	nephelometric turbidity unit
OSA	overburden storage area
PO_4	orthophosphate
SCDHEC	South Carolina Department of Health and Environmental Control
TDS	total dissolved solids
TKN	total Kjeldahl nitrogen
TN	total nitrogen
TSF	tailings storage facility
TSS	total suspended solids
USEPA	U.S. Environmental Protection Agency
USGS	U.S. Geological Survey

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J. SUPPORTING INFORMATION AND ANALYSIS FOR SURFACE WATER RESOURCES

J.1 Introduction

This appendix contains data to supplement Section 3.4, "Surface Water Hydrology and Water Quality" in the main volume of the Haile Gold Mine Project Draft EIS. The appendix includes meteorological, flow, and water quality data; descriptions of surface water impacts by mining features and activities; information on permits regulating surface water impacts; and monitoring for surface water impacts.

- **Meteorological Data –** Meteorological data are relevant to the affected environment for surface water hydrology because atmospheric conditions affect the water balance through processes such as precipitation and evaporation. Sources of data summarized in this appendix include AERMET data and two stations at Kershaw and Sandhill. In addition to understanding the meteorological conditions that drive streamflows in the study area, these data also are used to support the impacts analysis associated with changes in water temperature (Section 4.4 of the EIS).
- **Flow Data –** Streamflows are a critical component of surface water hydrology. This appendix presents data collected by the U.S. Geologic Survey (USGS) at two gages near the study area. Separation techniques developed by Ecological Resource Consultants, Inc. (ERC) (2012a) are used to partition total streamflows into runoff (flows resulting from precipitation falling on the land surface and running off into downstream waterbodies) and baseflow (flows resulting from groundwater contributions).
- **Water Quality Data –** In November 2012, Haile Gold Mine, Inc. (Haile) provided a database of water quality data. The database includes field parameters, nutrients, metals, and general chemistry. This appendix provides summary statistics for the data presented by sampling station. A map of the sampling stations is included in Section 3.4 of the EIS.

J.2 Meteorological Parameters

Meteorological data characterizing the climatic conditions around the study area were characterized with two different data sets. Data collected at the closest weather station in Kershaw (COOP Station 384690) were used to characterize the long-term temperature and precipitation in the area. A second dataset from the U.S. Environmental Protection Agency (USEPA) atmospheric data generation tool (AERMET) was used to characterize additional meteorological conditions (relative humidity, cloud cover, and wind speed). AERMET uses data from the National Weather Service, Federal Aviation Administration, and other sources. For the impacts analysis in Chapter 4 of the EIS, additional meteorological inputs were needed. Below are summaries of the AERMET data (2002–2006 provided by Haile) for air temperature, relative humidity, wind speed, and cloud cover, as well as a comparison to the long-term air temperature data observed at the Kershaw weather station. Pan evaporation data from the Sandhill Research station also is included.

J.2.1 Ambient Air Temperature

Monthly average temperature data for the Kershaw weather station from 1948 to 2005 are summarized in Table J-1. The minimum, maximum, and average temperatures for each day were calculated from the hourly data; and the average minimum, average maximum, and average temperatures for each month were calculated from the record. Average temperatures in summer typically approach 80 °F, and temperatures in winter are typically in the 40's.

Table J-1 Monthly Average Temperatures at the Kershaw Weather Station (ºF) (1948–2005)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Average maximum	53.9	57.6	65.3	74.6	81.5	87.3	90.1	88.3	82.8	73.8	64.9	55.9
Average minimum	29.2	31.4	38.0	46.7	55.9	64.0	68.2	67.1	60.8	48.7	38.5	31.2
Average	41.6	44.5	51.6	60.5	68.4	75.3	78.7	77.3	71.5	61.0	51.7	43.6

Hourly data also were analyzed: Table J-2, Table J-3, and Table J-4 list the 95th, 5th, and median and average summer (June–September) hourly temperatures, respectively.

Monthly AERMET data from 2002 to 2006 are presented in Table J-5 through Table J-7.

J.2.2 Relative Humidity

Hourly average relative humidity also was obtained from AERMET. Table J-8 through Table J-10 show the 95th, 50th, and 5th percentiles, respectively, for each month.

J.2.3 Wind Speed

Hourly average wind speeds in meters per second (m/s) generated by AERMET are presented below. Table J-11 through Table J-13 show the 95th, 50th, and 5th percentiles, respectively.

J.2.4 Cloud Cover

Hourly average cloud cover (%) using AERMET are presented below. The 95th percentile for cloud cover is 100 percent for every month and hour. Table J-14 and Table J-15 show the 50th and 5th percentiles for cloud cover, respectively.

J.2.5 Evaporation

Pan evaporation is a measurement dependent on temperature, precipitation, humidity, solar radiation, and wind. Table J-16 provides a summary of locally measured monthly pan evaporation rates between 1963 and 1992 from the Sandhill Research Station in Elgin, South Carolina, approximately 35 miles southwest of Haile Gold Mine. Pan evaporation is greatest during summer months on hot, dry, and sunny days—and lowest during the cool and humid fall and winter months.

J.2.6 Precipitation

Monthly total precipitation measured at the Kershaw COOP station (384690) is summarized in Table J-17. On average, August and September are generally the wettest months. The influence of tropical storms can be seen in the higher maximum rainfall amounts in July through November.

Table J-2 95th Percentile Hourly Temperature by Month at the Kershaw Weather Station (°F) (1948–2005)

Hour	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
1	51.0	53.5	58.0	64.3	69.6	74.7	76.5	75.5	73.0	66.2	60.8	53.4
2	50.0	52.5	57.1	63.1	68.5	73.6	75.3	74.4	71.9	65.4	59.9	52.4
3	49.4	51.7	56.3	62.0	67.7	72.7	74.5	73.6	71.1	64.6	59.3	51.5
4	48.8	50.8	55.7	61.5	67.0	72.1	73.8	73.0	70.6	64.2	58.7	50.8
5	48.3	50.3	55.2	61.1	66.5	71.7	73.3	72.7	70.2	64.0	58.2	50.3
6	48.0	50.0	55.0	61.0	66.3	71.5	73.0	72.5	70.0	64.0	58.0	50.0
7	51.0	53.6	58.1	64.3	69.9	75.1	76.6	75.7	73.0	66.2	60.9	53.5
8	54.0	56.5	61.6	68.2	73.4	78.5	80.2	79.1	76.2	69.1	63.4	56.5
9	57.3	59.1	65.2	71.7	76.8	82.0	83.9	82.5	79.5	71.8	65.6	59.4
10	60.9	62.4	68.7	75.5	80.3	85.6	87.5	86.1	82.8	74.8	68.5	62.4
11	63.7	65.6	71.8	79.0	83.7	88.7	90.6	89.2	85.6	77.7	71.2	65.6
12	66.6	68.4	74.9	82.0	86.4	91.3	93.4	91.9	88.2	80.1	73.6	68.2
13	69.0	70.7	77.2	84.6	88.8	93.4	95.6	94.0	90.3	82.2	75.8	70.4
14	70.8	72.9	79.2	86.5	90.5	95.0	97.3	95.7	91.8	83.8	77.5	72.3
15	71.8	73.8	80.6	87.7	91.7	96.2	98.4	96.7	92.8	84.8	78.7	73.6
16	72.0	74.0	81.0	88.0	92.0	96.5	98.7	97.0	93.0	85.0	79.0	74.0
17	68.8	71.1	77.4	84.6	88.8	93.4	95.4	94.0	90.4	82.3	75.8	70.3
18	65.8	68.1	74.1	81.2	85.7	90.6	92.6	90.9	87.6	79.4	72.9	67.4
19	63.1	65.1	71.1	78.1	82.8	87.7	89.4	88.1	84.7	76.8	70.3	64.7
20	60.7	62.4	68.2	75.5	80.1	85.1	86.8	85.4	82.4	74.5	68.1	62.1
21	58.3	60.4	65.7	72.6	77.6	82.6	84.2	82.8	79.9	72.4	66.1	60.0
22	56.1	58.6	63.3	70.4	75.3	80.4	81.9	80.7	77.9	70.7	64.5	58.1
23	54.0	56.6	61.5	68.1	73.1	78.1	79.7	78.7	75.8	68.7	63.1	56.0
24	52.5	55.0	60.0	66.2	71.4	76.5	78.0	77.0	74.3	67.3	61.7	54.9

Table J-3 5th Percentile Hourly Temperature by Month at the Kershaw Weather Station (°F) (1948–2005)

Hour	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
1	18.5	22.1	29.1	37.5	48.0	58.4	64.8	62.8	52.3	39.1	29.8	21.4
2	17.2	20.5	27.7	36.2	46.5	57.2	63.5	61.7	51.1	37.4	28.3	20.1
3	16.3	19.4	26.6	34.9	45.2	56.0	62.5	60.7	50.0	36.1	27.3	18.9
4	15.6	18.6	25.7	34.0	44.5	55.1	61.8	59.8	49.2	35.1	26.2	18.1
5	15.2	18.2	25.2	33.3	44.2	54.4	61.3	59.3	48.4	34.4	25.4	17.4
6	15.0	18.0	25.0	33.0	44.0	54.0	61.0	59.0	48.0	34.0	25.0	17.0
7	19.2	22.2	29.3	38.5	48.5	58.7	65.2	63.3	52.5	39.2	30.0	21.9
8	22.9	26.0	33.0	42.5	52.7	62.7	68.9	66.8	56.1	43.6	34.3	25.5
9	25.9	29.3	36.4	46.5	56.6	66.2	71.8	69.8	59.5	47.6	37.9	28.7
10	28.8	32.0	39.6	50.0	60.2	69.1	74.4	72.3	62.3	51.4	40.8	31.8
11	31.1	34.2	42.2	52.7	62.9	71.5	76.6	74.2	64.6	54.3	43.3	34.2
12	32.5	36.0	44.1	55.0	65.1	73.2	78.0	75.8	66.6	56.3	45.3	35.8
13	33.8	37.1	45.4	56.7	66.6	74.5	79.0	76.9	67.8	58.2	46.8	37.1
14	34.8	37.8	46.2	57.7	67.7	75.5	80.1	77.8	68.8	59.3	47.8	38.2
15	35.3	38.2	46.8	58.7	68.7	76.2	80.8	78.2	69.4	59.8	48.8	38.8
16	35.5	38.2	47.0	59.0	69.0	76.4	81.0	78.4	69.5	60.0	49.0	39.0
17	33.8	37.0	45.3	56.7	66.5	74.4	79.1	76.7	67.8	58.1	46.5	37.2
18	32.0	35.2	43.5	54.2	64.1	72.6	77.5	75.0	66.1	55.6	44.3	35.3
19	30.1	33.4	41.1	51.7	61.4	70.5	75.7	73.4	63.8	53.1	42.1	33.4
20	28.1	31.6	38.9	49.4	59.3	68.4	73.8	71.6	61.7	50.7	40.0	31.4
21	26.0	29.7	36.6	46.7	56.8	66.3	72.0	69.9	59.7	48.1	37.9	29.2
22	24.2	27.5	34.6	44.3	54.4	64.3	70.2	68.0	57.5	45.3	35.6	27.1
23	22.0	25.5	32.7	42.0	52.1	62.3	68.3	66.0	55.4	42.8	33.2	24.9
24	20.2	23.7	31.1	39.8	50.2	60.7	66.6	64.3	53.6	40.4	31.4	23.1

Table J-4 Median and Average Summer (June–September) Hourly Temperature at the Kershaw Weather Station (°F) (1948–2005)

Hour	Median	Average
1	69.8	68.6
2	68.8	67.5
3	67.9	66.6
4	67.4	66.0
5	67.1	65.5
6	67.0	65.3
7	70.0	68.8
8	73.1	72.1
9	76.1	75.1
10	79.0	78.2
11	81.6	80.8
12	83.8	83.0
13	85.6	84.8
14	87.0	86.1
15	87.8	87.0
16	88.0	87.2
17	85.6	84.8
18	83.2	82.4
19	80.8	79.9
20	78.7	77.8
21	76.5	75.6
22	74.6	73.6
23	72.8	71.6
24	71.3	70.1

Table J-5 95th Percentile Hourly Temperature by Month from the AERMET Data (°F) (2002–2006)

Hour	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
1	60.0	56.8	64.0	71.0	74.8	76.7	80.0	79.1	75.7	71.7	68.6	56.8
2	59.0	57.1	64.5	69.7	71.7	75.7	78.7	78.7	74.8	69.7	68.6	56.9
3	59.6	55.9	64.0	68.6	71.7	75.7	77.6	77.1	74.8	69.0	67.2	57.3
4	58.7	55.9	62.2	66.7	71.7	74.8	76.7	76.7	74.8	69.7	66.7	56.1
5	58.7	55.3	61.3	67.2	71.0	74.3	76.7	76.7	73.9	68.6	66.4	56.1
6	57.0	55.3	60.7	65.9	71.0	74.8	76.0	75.7	73.9	68.6	67.2	57.3
7	58.0	55.0	60.0	67.7	74.1	76.2	78.7	78.0	73.9	68.6	67.7	56.1
8	56.8	55.0	62.2	73.0	76.9	80.3	83.8	82.0	75.7	71.0	66.2	55.1
9	59.6	56.8	65.1	76.2	80.1	83.8	86.6	85.9	78.7	73.1	68.2	55.9
10	62.7	59.6	68.6	80.0	82.9	86.2	89.7	89.7	82.9	76.0	71.0	58.2
11	65.8	62.0	73.5	83.3	85.7	87.7	92.1	92.8	85.2	78.7	74.8	62.5
12	68.0	64.3	75.7	85.2	87.0	89.7	92.9	93.1	89.0	80.7	77.2	64.5
13	69.7	65.8	77.0	87.2	89.2	91.4	94.7	94.8	89.7	82.9	78.2	66.0
14	71.7	67.9	78.0	87.7	90.1	91.9	95.3	95.6	90.4	83.8	80.4	67.8
15	71.6	68.6	80.0	87.7	90.1	92.3	96.0	96.0	90.4	83.9	81.4	68.1
16	71.6	69.7	78.0	86.8	89.7	91.9	95.6	95.6	91.0	83.1	79.8	67.7
17	69.7	67.9	76.9	85.8	89.1	91.9	95.1	94.7	89.7	81.1	76.0	64.2
18	66.1	65.8	75.7	83.3	85.9	91.0	93.7	91.9	84.7	80.0	73.1	60.7
19	65.1	62.7	71.7	80.7	83.8	86.2	91.9	88.1	82.0	76.7	71.0	60.0
20	64.2	60.7	69.7	77.6	80.7	83.8	86.6	85.9	80.0	74.8	70.4	58.9
21	63.3	59.6	67.9	77.3	80.0	81.4	85.7	83.9	77.6	73.0	69.2	58.9
22	62.2	58.7	66.7	74.8	78.7	80.0	83.8	82.9	76.7	71.7	69.2	57.7
23	61.3	57.7	65.9	73.4	76.7	77.6	82.3	80.7	76.7	71.7	69.2	56.9
24	61.1	57.7	65.8	72.6	75.3	77.3	80.7	80.6	75.7	71.0	67.8	55.7

Table J-6 50th Percentile Hourly Temperature by Month from the AERMET Data (°F) (2002–2006)

Hour	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
1	39.7	40.7	50.6	58.7	64.9	71.0	73.9	74.8	69.7	59.6	48.7	39.7
2	38.8	39.7	49.9	57.7	64.0	71.0	73.9	73.9	67.9	58.7	47.9	38.8
3	37.9	39.1	49.7	56.8	62.7	71.0	73.3	73.0	67.7	57.7	46.9	37.9
4	37.0	38.8	48.7	55.9	62.7	69.7	73.0	73.0	66.7	57.7	46.9	37.0
5	35.7	37.0	46.9	54.3	62.0	68.6	73.0	73.0	66.4	57.7	46.6	35.7
6	35.7	37.0	46.3	53.7	62.0	69.7	73.0	71.7	65.8	57.7	46.0	35.7
7	35.0	37.0	46.0	55.9	64.0	71.7	74.8	73.9	66.7	56.8	46.9	35.7
8	35.0	37.0	48.1	59.3	66.7	74.8	76.9	76.7	71.0	59.6	47.8	35.7
9	39.1	40.9	51.7	64.0	69.7	77.3	80.7	78.7	73.9	62.7	51.7	39.7
10	44.0	44.7	53.7	65.8	73.0	80.0	82.9	82.0	76.7	64.9	55.9	44.0
11	46.9	47.8	56.8	67.7	73.9	82.0	85.7	83.8	78.7	67.7	58.7	47.8
12	48.7	49.7	58.9	71.0	76.7	82.9	85.9	85.7	80.2	68.6	60.7	49.9
13	50.6	51.7	60.7	71.7	77.6	83.8	87.7	86.6	80.7	69.7	62.3	53.0
14	50.6	53.0	62.0	73.6	77.6	84.7	89.0	87.7	82.1	71.0	63.3	53.5
15	51.7	53.7	62.7	73.3	78.7	84.7	89.0	87.7	82.3	71.0	64.0	53.7
16	51.7	53.0	64.0	73.0	78.7	84.7	87.7	86.6	82.0	71.0	63.3	53.7
17	50.6	53.0	62.7	73.0	77.6	84.1	87.7	85.7	80.7	68.6	59.6	51.7
18	47.8	50.6	60.7	71.5	75.7	82.9	84.7	83.8	77.6	64.9	56.8	47.8
19	46.0	47.8	57.7	66.7	73.0	79.3	82.9	80.7	74.8	64.0	55.9	46.0
20	44.5	46.9	55.9	64.9	69.7	75.7	80.0	78.7	73.9	62.7	54.3	44.7
21	42.7	46.0	53.7	63.3	68.6	74.8	77.6	76.7	73.0	62.5	53.6	44.0
22	42.7	44.0	53.0	62.0	67.7	73.9	76.7	75.7	71.7	62.0	51.7	42.7
23	40.7	44.0	51.7	60.7	66.1	73.0	75.7	75.1	71.0	60.7	49.8	41.6
24	39.7	42.7	51.7	59.6	64.9	71.7	74.8	74.8	69.7	59.6	49.7	40.7

Table J-7 5th Percentile Hourly Temperature by Month from the AERMET Data (°F) (2002–2006)

Hour	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
1	26.5	29.8	33.4	44.7	50.4	62.7	67.7	66.7	58.1	44.0	35.0	27.6
2	24.4	30.1	32.0	44.0	49.9	62.0	67.9	67.4	57.2	42.7	33.1	26.7
3	24.4	28.9	31.9	41.6	49.9	60.1	67.7	66.7	56.3	42.4	31.9	24.7
4	23.0	28.0	31.4	40.7	48.7	59.6	67.4	65.8	55.4	42.7	32.6	26.0
5	22.7	28.0	30.5	40.1	47.5	57.7	66.7	65.8	54.3	40.4	31.8	26.0
6	21.7	26.7	30.0	38.3	47.8	58.7	66.1	64.2	53.3	38.8	31.1	25.3
7	21.7	26.7	29.5	42.7	51.4	62.7	69.4	67.7	56.3	39.4	30.2	23.6
8	21.7	28.9	35.0	46.0	54.6	66.4	71.6	69.4	61.3	46.0	32.6	24.7
9	23.6	31.7	38.8	48.2	55.9	67.9	73.9	71.5	64.1	51.1	38.9	30.4
10	26.5	33.7	41.4	49.5	55.9	69.7	74.8	72.6	66.2	53.5	42.7	32.6
11	28.2	33.7	41.4	48.7	57.0	71.6	75.1	73.6	67.7	55.2	44.9	33.7
12	29.8	37.0	43.6	50.1	58.7	73.0	76.7	74.2	69.1	55.2	46.8	34.6
13	30.7	37.0	44.7	51.7	59.6	73.6	77.6	75.4	70.3	55.9	47.8	36.6
14	32.0	37.9	46.0	52.6	60.7	73.6	78.4	74.8	71.2	56.3	48.1	36.4
15	33.4	38.8	46.3	53.2	60.7	74.0	78.4	76.4	71.6	56.3	48.1	37.0
16	33.4	39.7	46.9	53.9	61.6	74.7	76.7	75.4	71.7	56.8	48.2	37.6
17	31.9	38.8	46.2	53.0	59.6	73.0	75.7	73.9	71.7	54.6	46.0	36.6
18	31.4	37.9	45.6	51.2	59.6	71.7	73.2	73.0	67.8	50.6	44.0	34.6
19	28.6	35.7	42.4	49.5	59.4	69.7	73.0	71.7	65.3	49.7	41.6	32.4
20	28.9	35.0	40.4	48.7	57.4	67.8	73.0	69.7	62.5	48.1	40.8	31.9
21	28.6	33.7	39.7	47.8	55.9	66.4	71.6	70.6	60.7	48.0	39.7	32.6
22	28.0	31.7	38.8	46.0	54.6	64.9	70.6	69.4	62.0	46.6	38.8	31.1
23	26.7	31.9	38.8	46.4	52.6	64.6	71.0	68.6	58.9	45.8	35.2	29.8
24	27.0	31.7	35.3	46.0	51.4	64.0	69.4	68.6	57.9	44.6	35.6	28.7

Table J-8 95th Percentile Hourly Relative Humidity by Month from the AERMET Data (%) (2002–2006)

Hour	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
1	100	100	100	100	100	96	99	99	100	100	98	100
2	100	100	100	100	100	96	100	99	100	100	99	100
3	100	100	100	100	100	96	99	100	100	100	100	100
4	100	100	100	100	100	99	100	100	100	100	100	100
5	100	100	100	100	100	99	100	100	100	100	100	100
6	100	100	100	100	100	99	100	100	100	100	100	100
7	100	100	100	100	100	96	100	100	100	100	100	100
8	100	100	100	100	96	95	96	96	96	99	100	100
9	100	100	100	96	96	93	93	93	93	97	96	100
10	100	100	100	95	93	90	89	90	92	96	96	100
11	100	100	100	95	93	90	87	89	88	96	96	96
12	99	96	96	95	89	88	84	86	88	94	95	94
13	96	96	96	92	88	88	78	87	84	93	93	92
14	100	95	96	92	89	89	74	88	86	93	93	93
15	95	96	94	91	89	88	79	86	93	96	93	92
16	96	95	93	89	89	87	86	88	90	94	96	93
17	95	95	96	93	91	89	86	90	92	93	93	95
18	99	100	100	96	93	93	90	93	93	94	96	97
19	99	100	100	96	96	93	93	96	96	96	96	97
20	100	100	100	96	96	93	96	94	96	99	96	100
21	100	100	100	96	96	96	96	96	96	97	96	100
22	100	100	100	100	97	96	96	96	96	99	96	100
23	100	100	100	100	97	96	96	97	98	100	96	100
24	100	100	100	98	99	99	99	99	98	100	98	100

Table J-9 50th Percentile Hourly Relative Humidity by Month from the AERMET Data (%) (2002–2006)

Hour	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
1	70	68	66	69	80	86	87	90	86	89	79	70
2	72	69	69	72	86	89	89	93	88	90	82	73
3	75	72	72	77	86	90	90	93	89	92	86	75
4	77	73	73	79	89	91	93	93	90	92	86	78
5	78	77	78	82	89	93	93	93	92	93	88	79
6	79	78	79	84	89	90	93	93	92	93	89	80
7	77	79	79	82	84	86	89	90	89	93	92	80
8	80	75	76	69	78	78	81	84	82	88	86	80
9	74	68	66	62	70	70	73	78	73	77	72	71
10	62	57	55	54	63	64	66	70	67	69	60	58
11	53	52	51	47	58	60	61	65	61	65	52	50
12	45	47	46	43	55	55	56	61	59	61	48	45
13	44	44	43	40	50	52	54	57	55	58	45	42
14	41	42	39	38	49	52	52	56	52	55	43	40
15	39	39	39	37	47	52	52	56	53	54	43	37
16	41	39	36	37	47	52	54	56	53	55	44	39
17	44	39	37	39	47	54	54	60	55	62	50	43
18	51	44	40	42	51	58	60	65	64	72	58	50
19	54	51	45	48	60	66	67	73	70	77	62	53
20	59	52	51	55	67	73	73	81	73	80	65	57
21	61	57	55	57	68	78	78	83	75	80	67	59
22	61	60	59	60	73	81	81	84	78	83	71	62
23	63	62	62	63	76	83	84	87	81	86	75	64
24	68	63	65	66	78	86	87	89	83	86	78	66

Table J-10 5th Percentile Hourly Relative Humidity by Month from the AERMET Data (%) (2002–2006)

Hour	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
1	38	42	34	40	51	61	69	62	60	67	53	40
2	36	41	36	40	57	64	72	67	67	67	54	38
3	38	41	39	46	61	69	74	71	66	69	54	39
4	37	45	40	49	63	68	79	77	69	69	52	42
5	36	45	42	51	64	73	82	78	71	72	55	42
6	41	45	43	53	64	77	80	81	71	74	57	45
7	42	44	45	54	56	65	73	74	69	72	57	47
8	44	44	41	41	50	56	64	65	62	61	51	46
9	38	41	32	30	41	49	56	57	54	52	44	40
10	32	33	28	24	37	44	49	50	46	42	38	35
11	29	26	24	23	33	41	43	45	43	37	29	30
12	26	25	22	23	32	36	40	40	39	34	25	23
13	22	23	19	22	31	35	39	37	35	32	24	21
14	20	19	18	21	29	32	38	34	34	31	22	18
15	20	19	17	20	29	31	35	32	33	30	21	17
16	19	19	17	21	28	31	35	33	33	30	22	19
17	21	19	18	20	27	31	36	32	37	36	25	21
18	26	22	19	22	28	35	37	35	41	47	32	27
19	30	25	21	25	37	38	40	42	47	52	34	31
20	32	27	24	27	41	43	47	47	52	54	37	33
21	34	32	24	30	46	46	50	51	53	58	41	36
22	33	34	29	34	46	53	55	52	56	61	45	38
23	35	35	31	37	51	56	60	56	58	61	48	40
24	37	34	33	39	53	58	68	59	58	65	47	42

Table J-11 95th Percentile Hourly Wind Speed by Month from the AERMET Data (m/s) (2002–2006)

Hour	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
1	5.1	5.2	5.3	6.2	4.7	4.6	3.6	4.1	4.9	4.6	6.0	5.2
2	5.2	5.7	5.7	5.7	4.6	4.1	3.6	3.6	4.9	4.1	5.7	5.1
3	5.7	5.7	5.7	5.2	4.6	3.9	3.6	3.6	5.2	4.1	6.2	4.6
4	4.8	6.2	5.2	5.5	4.6	3.6	3.1	3.6	4.6	4.1	5.5	4.8
5	5.3	5.7	4.6	4.6	4.1	4.4	3.1	3.6	4.6	4.1	5.2	5.1
6	5.2	5.7	5.2	4.6	4.6	4.1	3.1	3.6	4.6	4.1	5.2	5.1
7	5.2	5.7	5.2	5.2	4.6	4.4	3.2	4.1	4.9	4.1	5.7	4.6
8	5.2	5.7	6.2	6.0	4.7	5.2	4.1	4.6	5.2	4.6	6.0	4.8
9	5.8	6.2	6.2	6.0	5.2	5.5	4.1	4.6	6.2	5.1	5.7	5.2
10	5.8	6.2	6.2	6.2	5.7	5.7	4.6	4.2	6.7	5.2	7.7	5.7
11	6.3	6.2	6.7	6.5	5.7	5.5	4.6	5.2	6.5	6.2	7.0	5.7
12	6.2	7.2	6.2	6.2	5.3	5.2	4.2	5.3	6.7	5.7	7.5	5.7
13	6.7	6.7	6.8	6.7	6.2	5.7	4.6	5.1	6.7	5.8	7.2	5.7
14	6.3	7.2	6.7	6.7	5.7	5.7	5.1	5.2	5.7	5.7	7.0	6.2
15	6.7	6.2	6.7	7.2	6.7	5.7	5.2	5.2	5.7	5.7	7.2	6.2
16	6.8	6.7	7.2	7.2	6.2	5.2	5.3	5.7	6.2	5.7	6.5	6.2
17	6.2	6.7	6.7	6.7	5.3	6.2	5.7	5.8	5.5	5.1	6.5	5.2
18	6.3	5.7	5.7	6.7	5.2	5.2	5.7	5.2	5.5	4.6	5.7	5.2
19	5.3	5.7	5.3	7.0	5.2	5.2	4.6	4.6	4.6	4.6	5.2	5.3
20	5.7	5.2	5.8	5.7	4.8	4.6	4.6	4.6	4.6	4.6	5.5	5.2
21	5.7	5.7	5.7	5.2	4.6	4.6	4.2	4.6	4.6	4.2	5.2	5.3
22	5.2	5.7	5.7	5.7	4.6	4.6	4.1	4.6	4.9	4.2	5.2	5.2
23	5.2	6.2	5.3	5.5	4.6	4.6	3.6	4.1	5.2	4.2	6.0	4.6
24	5.2	5.2	5.7	5.5	4.6	4.4	3.6	3.6	4.6	4.1	6.0	5.2

m/s = meters per second

Table J-12 50th Percentile Hourly Wind Speed by Month from the AERMET Data (m/s) (2002–2006)

Hour	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
1	2.6	2.1	2.6	2.6	2.1	2.1	1.5	1.5	2.4	1.5	1.5	1.5
2	2.1	2.1	2.6	2.1	2.1	2.1	1.5	1.5	2.1	1.5	2.1	1.5
3	2.1	2.1	2.1	2.1	2.1	1.5	1.5	1.5	2.1	1.5	2.1	2.1
4	2.1	2.1	2.1	2.1	2.1	1.5	1.5	1.5	2.1	1.5	2.1	2.1
5	2.1	2.1	2.1	2.1	1.5	1.5	1.5	1.5	2.4	1.5	2.0	1.5
6	2.1	2.1	2.1	2.1	2.1	2.1	1.5	1.5	2.6	2.1	2.1	1.5
7	2.1	2.1	2.1	2.1	2.1	2.1	2.1	1.5	2.6	2.1	2.1	1.5
8	2.1	2.1	2.6	3.1	2.6	2.6	2.1	2.1	2.6	2.1	2.1	1.5
9	2.6	2.6	3.6	3.1	2.6	2.6	2.1	2.1	3.1	2.6	2.6	2.1
10	3.1	3.1	3.6	3.1	2.6	2.6	2.6	2.1	3.6	3.1	3.1	2.6
11	3.4	3.6	3.6	3.6	3.1	3.1	2.6	2.6	3.6	3.1	2.6	3.1
12	3.6	3.6	3.6	3.6	3.1	3.1	2.6	2.6	3.6	3.1	3.1	3.1
13	3.6	3.6	3.6	3.9	3.1	2.6	2.6	2.6	3.1	3.1	3.1	3.1
14	3.6	3.6	4.1	3.7	3.1	3.1	2.6	2.6	3.6	3.1	3.1	3.3
15	3.6	3.6	3.6	4.1	3.6	3.1	2.8	2.6	3.1	3.1	2.9	3.1
16	3.1	3.6	4.1	4.1	3.6	3.1	2.6	2.6	3.1	2.6	3.1	3.1
17	3.1	3.1	3.6	3.6	3.1	2.6	2.6	3.0	3.1	2.1	2.6	2.6
18	2.1	2.6	3.1	3.1	2.6	2.6	2.1	2.6	2.6	2.1	2.1	2.1
19	2.1	2.6	2.6	2.6	2.1	2.1	2.1	2.1	2.6	2.1	2.1	2.1
20	2.6	2.6	2.6	2.6	2.1	2.1	2.1	2.1	2.6	2.1	2.1	2.1
21	2.6	2.1	2.6	2.6	2.1	2.1	2.1	2.1	2.6	2.1	2.1	2.1
22	2.6	2.6	2.6	2.4	2.1	2.1	2.1	2.1	2.6	2.1	2.1	2.1
23	2.6	2.6	2.6	2.6	2.1	1.5	1.5	1.5	2.1	2.1	2.1	2.1
24	2.6	2.1	2.6	2.1	2.1	1.5	1.5	1.5	2.6	2.1	1.7	1.5

m/s = meters per second

Table J-13 5th Percentile Hourly Wind Speed by Month from the AERMET Data (m/s) (2002–2006)

Hour	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
10	0.0	0.0	1.1	0.0	0.0	0.7	0.0	0.0	0.0	0.0	0.0	0.0
11	0.0	0.0	0.0	1.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
12	0.0	0.0	1.1	1.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
13	1.1	0.0	1.5	0.0	1.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0
14	0.0	0.0	1.5	0.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
15	1.5	0.0	1.5	1.5	1.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0
16	0.0	0.0	1.1	1.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
17	0.0	0.0	1.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
18	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
19	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
20	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
21	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
22	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
23	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
24	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

m/s = meters per second

Table J-14 50th Percentile Hourly Cloud Cover by Month from the AERMET Data (%) (2002–2006)

Hour	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
1	70	80	80	50	80	80	80	80	65	80	65	50
2	50	90	90	40	90	90	50	90	60	90	90	50
3	50	100	90	50	90	90	50	90	50	90	50	90
4	50	90	90	50	80	80	80	80	50	80	65	50
5	50	100	90	50	90	90	50	90	50	90	70	50
6	50	90	90	90	90	90	90	90	90	90	50	50
7	80	90	100	80	80	80	80	80	80	80	80	50
8	90	90	90	90	90	90	90	90	90	90	90	50
9	90	90	90	90	90	90	90	90	90	90	80	50
10	90	90	90	80	80	80	80	80	80	90	80	80
11	90	90	90	90	90	90	90	90	90	90	90	50
12	90	90	90	90	90	90	90	90	90	90	90	50
13	80	80	80	80	80	80	80	80	80	80	80	50
14	90	90	90	90	90	90	90	90	90	90	90	90
15	90	90	90	90	90	90	90	90	90	90	90	90
16	80	90	90	80	80	80	80	80	80	80	80	50
17	90	90	90	90	90	90	90	90	50	90	90	70
18	90	90	90	90	90	90	90	90	50	50	50	50
19	70	80	80	50	80	80	80	80	50	80	50	50
20	50	90	90	50	90	90	90	90	50	90	50	50
21	50	90	90	50	90	90	90	90	50	90	50	50
22	50	80	80	50	80	80	80	80	50	80	50	50
23	50	90	90	50	90	90	90	90	50	90	50	30
24	50	90	90	50	90	90	90	90	50	90	50	50

Table J-15 5th Percentile Hourly Cloud Cover by Month from the AERMET Data (%) (2002–2006)

Hour	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
1	0	0	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0	0	0	0	0	0
9	0	0	0	0	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	0	0	0	0	0
11	0	0	0	0	0	0	0	30	0	0	0	0
12	0	0	0	0	21	0	30	30	0	0	0	0
13	0	0	0	0	0	30	30	30	9	0	0	0
14	0	0	0	0	21	0	30	30	14	0	0	0
15	0	0	0	0	30	30	30	30	14	0	0	0
16	0	0	0	0	30	30	30	30	25	0	0	0
17	0	0	0	0	30	30	30	30	0	0	0	0
18	0	0	0	0	30	30	30	30	0	0	0	0
19	0	0	0	0	30	14	30	30	0	0	0	0
20	0	0	0	0	30	0	30	0	0	0	0	0
21	0	0	0	0	0	0	0	0	0	0	0	0
22	0	0	0	0	0	0	0	0	0	0	0	0
23	0	0	0	0	0	0	0	0	0	0	0	0
24	0	0	0	0	0	0	0	0	0	0	0	0

Table J-16 Average Monthly Pan Evaporation at the Sandhill Research Station (inches) (1963–1992)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Average monthly evaporation	1.8	2.72	4.76	7.34	7.81	8.23	8.49	7.12	5.88	4.79	3.19	1.98
Annual average	64.1											

Source: Schlumberger 2010.

Table J-17 Minimum, Average, Median, and Maximum Monthly Rainfall at Kershaw (inches) (1951–2005)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Minimum	0.69	0.93	0.60	0.19	0.60	0.54	1.17	0.51	0.00	0.00	0.39	0.27
Average	4.25	3.70	4.64	3.49	3.46	4.01	5.20	4.41	3.93	3.18	3.18	3.22
Median	3.81	3.55	4.36	3.25	3.43	3.90	4.56	3.52	3.53	2.67	2.83	2.98
Maximum	9.64	6.70	12.00	7.62	7.73	7.96	12.98	18.55	11.68	16.20	11.77	7.52

J.3 Flow Data

Natural streamflows are generally comprised of two components: (1) baseflow, which is the relative steady contribution from the groundwater; and (2) runoff, which occurs when precipitation falls on the land surface and flows into waterbodies. To describe the current flow conditions for streams in the study area, ERC developed estimates of average total flow and average baseflow (described in Section 3.4 of the EIS) based on data collected at a nearby USGS flow monitoring stations on Hanging Rock Creek (USGS Gage 02131472) (Figure J-1). Flows were prorated by drainage area to estimate flows for the streams in the study area (see ERC 2012a). This gage provides continuous daily flow observations over a 23-year period of record from October 1980 to October 2003.

In addition, USGS operated a gage in nearby Little Fork Creek (USGS Gage 02131320) from 1990 to 2001 and from 2008 to 2012. This gage provides an indication of relative flow conditions that correspond with Haile's more recent data collection efforts. Figure J-1 provides a map showing the location of both gages relative to the Project boundary.

J.3.1 Hanging Rock Creek Gage

As noted, the USGS operates a stream gage (USGS 02131472) in Hanging Rock Creek near Kershaw. The gage is located approximately 5 miles from the Project area at the following coordinates: 34.51611, -80.58306. The drainage area for the watershed at this gage is 23.9 square miles (15,296 acres). Daily discharge data are available from October 1980 to October 2003, and gage height data are available from October 1992 to October 2003. The USGS continues to report the annual only peak streamflow at this gage.

The hydrologic condition at the Hanging Rock Creek gage is relatively similar to conditions observed at the Project site (ERC 2012a). While there is a water supply reservoir upstream of the Hanging Rock Creek gage, this is a run-of-the-river impoundment with uncontrolled releases. The water supply withdrawal and the wastewater return are both upstream of the Hanging Rock Creek gage. The assumed net withdrawal is approximately 0.1 cubic foot per second (cfs), and the net loss results in a conservative estimate of flows calculated using this gage as an index (ERC 2013a). Application and validation of this gage to estimate historical flows at the Project site are described in ERC (2012).

Flow data reported by the USGS are provided in Figure J-2 and Figure J-3, which show the mean daily flow and annual peak flows, respectively. Streamflow data collected at the Hanging Rock Creek gage provide a daily flow time series for a 23-year period (1980–2003). Figure J-4 shows the baseflow separation for the 23-year period of record at the Hanging Rock Creek gage. Baseflow separation is a hydrologic method where flows attributed to surface runoff are separated from groundwater flows (baseflows). On average, approximately 33 percent of the annual flow is attributed to runoff (ERC 2012a).

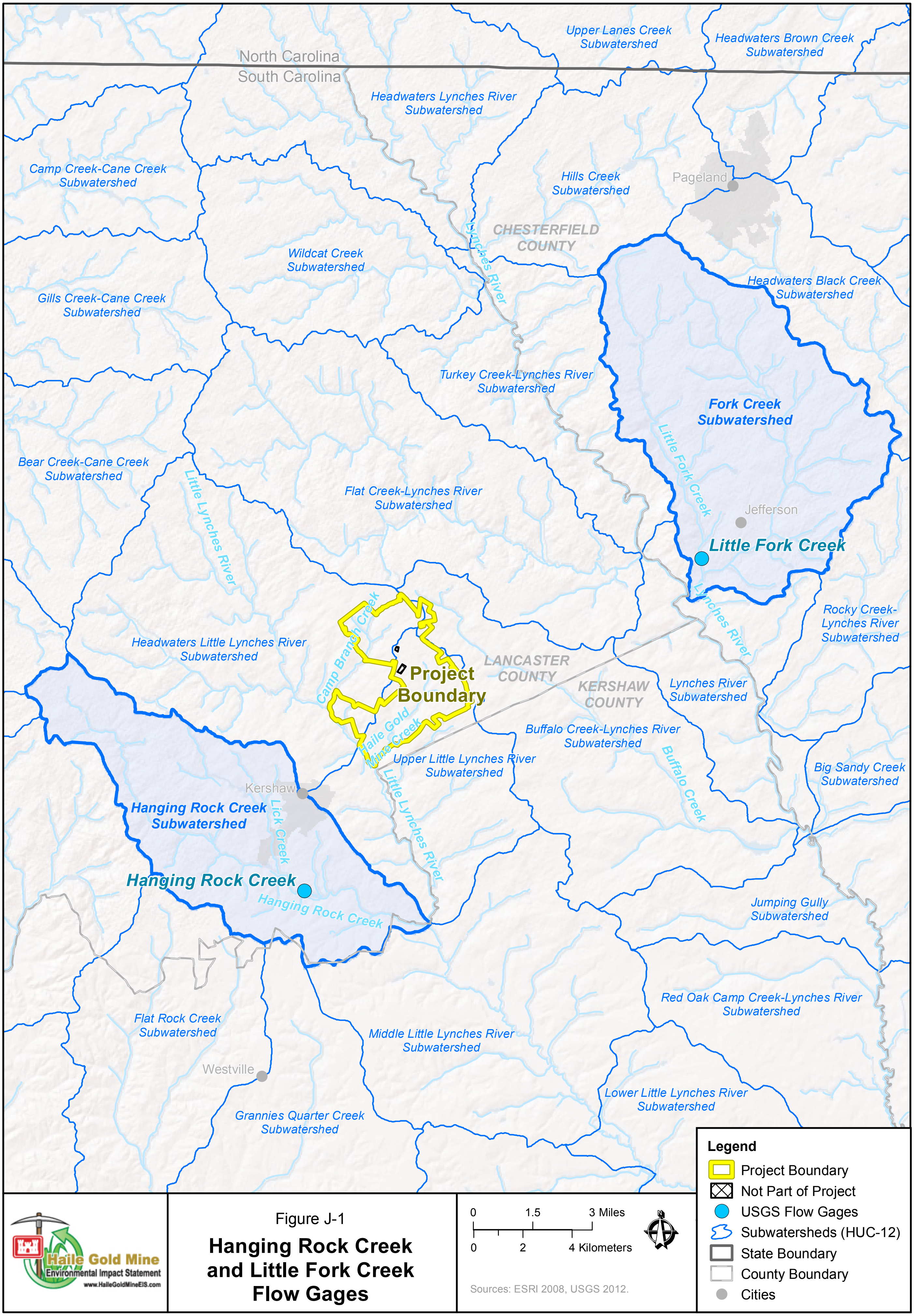

Figure J-1

Hanging Rock Creek and Little Fork Creek Flow Gages

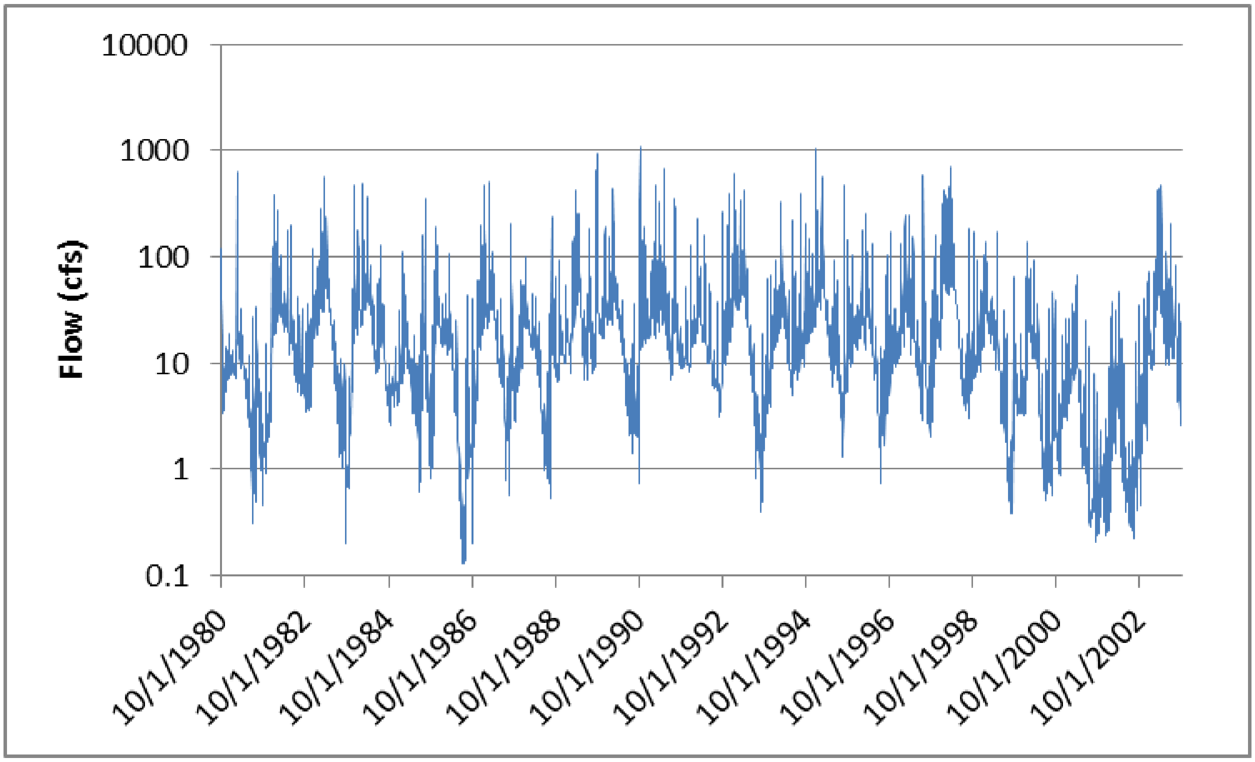

Figure J-2 Mean Daily Flow at the Hanging Rock Creek Gage (1980–2003)

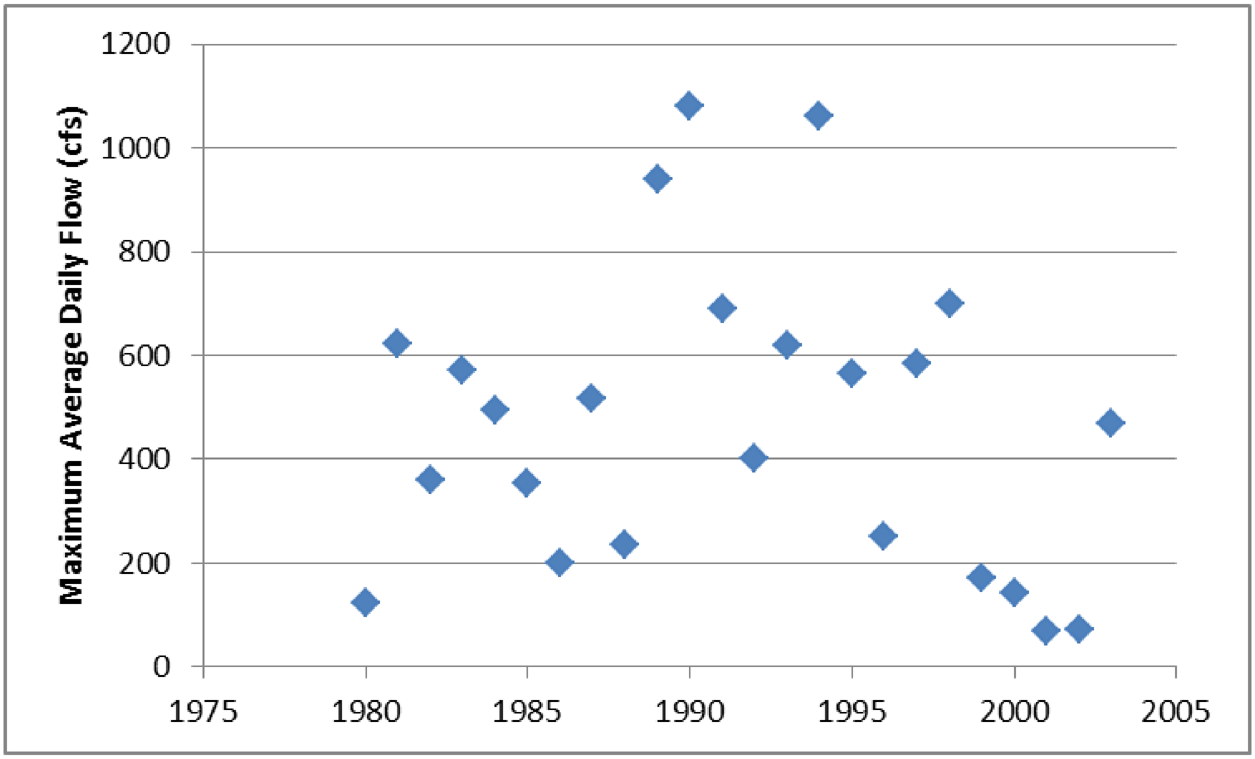

Figure J-3 Annual Peak Flow at the Hanging Rock Creek Gage (1980 to present)

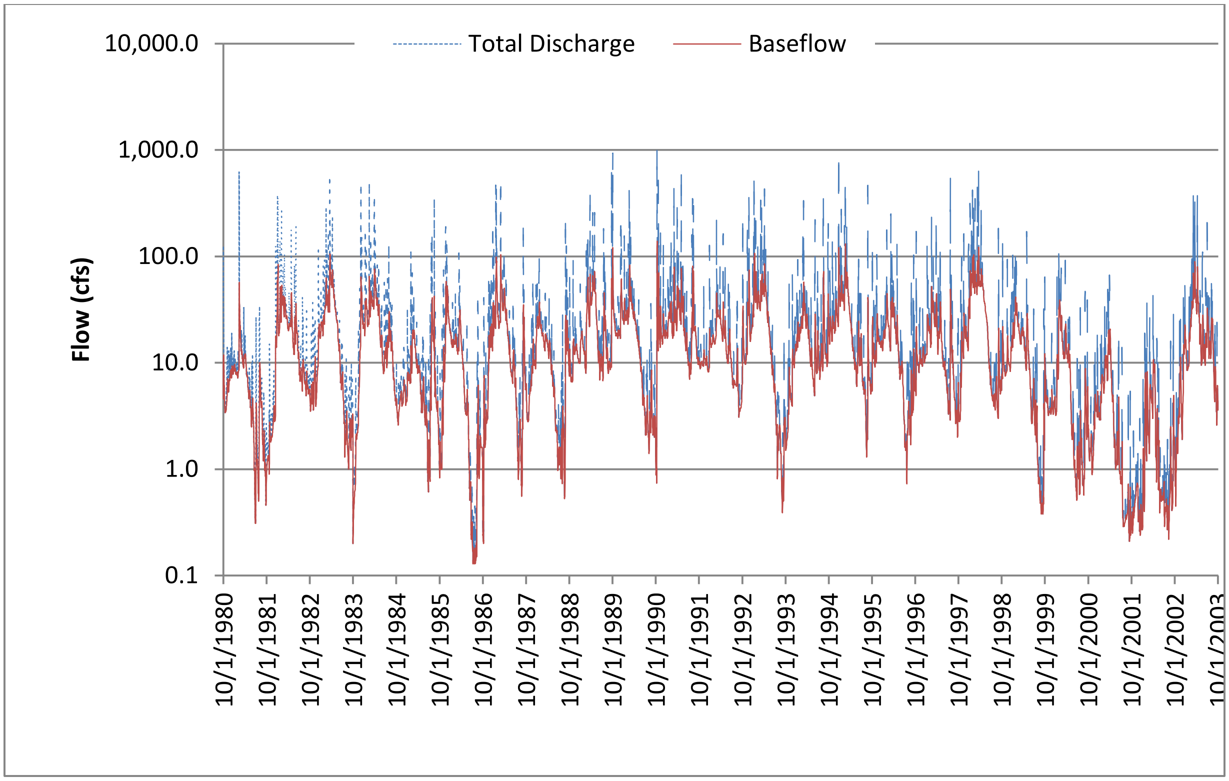

Figure J-4 Baseflow Separation of the Hanging Rock Creek Gage Data

Table J-18 through Table J-20 present the average monthly total flow, average monthly baseflows, and average monthly runoff flows based on the baseflow separation analysis developed by ERC (2012). The highest average monthly flows typically occur in January through March, while the lowest average monthly flows occur from June to September. The highest annual average monthly flow was in 1998 and 1989. The lowest average monthly flows were in 2001 and 2002, the last 2 full years of recorded data. Overall, the average monthly total flow for all months of record was 24.1 cfs, the average monthly runoff flow was 8.8 cfs, and monthly average baseflow was 15.3 cfs.

Table J-18 Average Monthly Total Flow for Hanging Rock Creek (cfs) (1980–2003)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	AVG
1980										10.5	8.8	10.1	
1981	8.7	42.8	13.2	9.0	5.1	2.5	4.6	7.7	1.9	2.5	2.8	37.6	11.6
1982	72.7	58.3	33.5	38.5	25.6	28.3	9.9	9.3	8.0	7.3	10.8	22.8	27.1
1983	30.3	61.2	98.2	67.4	26.2	11.6	5.0	3.1	4.1	1.7	9.7	58.8	31.4
1984	41.0	61.0	64.9	52.4	27.2	12.7	27.5	21.5	6.1	4.5	5.7	6.2	27.6
1985	13.0	23.6	13.2	8.3	7.2	3.5	29.9	32.7	3.5	3.7	53.3	39.4	19.3
1986	18.4	18.1	28.5	10.7	5.1	1.0	0.3	4.7	2.1	6.5	17.8	36.2	12.4
1987	85.5	50.4	71.1	34.0	13.7	12.6	4.0	3.2	29.4	4.9	13.8	18.4	28.4
1988	34.6	20.6	19.1	16.0	8.1	2.3	2.5	16.8	25.6	11.2	19.6	11.4	15.7
1989	20.3	29.6	69.5	61.0	45.2	14.3	39.6	16.3	44.9	73.1	22.0	51.0	40.6
1990	39.4	70.3	43.9	24.2	14.5	6.0	4.1	7.1	3.5	114.5	28.2	26.7	31.9
1991	34.1	35.3	75.5	47.8	67.4	19.8	14.5	77.6	13.9	10.7	12.3	16.3	35.4
1992	18.8	33.7	33.0	31.1	18.8	19.1	7.4	10.6	5.5	26.4	63.4	29.9	24.8
1993	108.4	45.6	78.6	72.4	23.4	9.9	3.7	2.3	2.9	5.8	10.4	14.7	31.5
1994	27.1	35.9	49.4	19.1	10.9	29.2	15.3	51.1	32.1	25.4	38.2	86.3	35.0
1995	64.7	106.6	54.5	19.3	11.3	27.1	9.1	24.2	7.4	24.5	27.1	16.2	32.7
1996	26.5	34.7	47.7	28.6	14.7	8.0	2.6	7.7	14.0	18.6	13.1	14.7	19.3
1997	30.3	47.4	45.9	33.1	17.7	9.3	34.0	12.3	5.7	14.4	28.4	34.5	26.1
1998	108.4	100.6	113.5	77.0	32.5	12.9	5.5	6.4	17.0	17.7	14.8	16.7	43.6
1999	39.6	30.4	21.8	20.7	18.4	6.2	4.9	0.8	8.0	6.1	5.0	4.7	13.9
2000	28.3	29.1	20.3	15.3	3.7	1.5	3.2	1.6	9.2	2.1	4.4	5.0	10.3
2001	7.5	11.1	22.0	10.1	2.1	3.7	1.2	0.4	0.8	0.6	0.7	0.6	5.1
2002	6.1	6.6	7.9	9.2	3.8	0.7	0.6	1.8	3.6	2.7	9.4	20.6	6.1
2003	14.2	40.8	89.9	60.0	28.2	18.9	30.7	24.2	9.2	3.7			
Minimum month	6.1	6.6	7.9	8.3	2.1	0.7	0.3	0.4	0.8	0.6	0.7	0.6	5.1
Median month	30.3	35.9	45.9	28.6	14.7	9.9	5.0	7.7	7.4	6.9	13.1	18.4	26.6
Average month	38.2	43.2	48.5	33.3	18.7	11.4	11.3	14.9	11.2	16.6	18.3	25.2	24.1
Maximum month	108.4	106.6	113.5	77.0	67.4	29.2	39.6	77.6	44.9	114.5	63.4	86.3	43.6

cfs = cubic feet per second

Table J-19 Average Monthly Baseflow for Hanging Rock Creek (cfs) (1980–2003)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	AVG
1980										5.49	2.33	1.75	
1981	0.57	23.79	2.19	0.44	0.90	0.48	3.20	2.78	0.78	1.08	0.62	25.08	5.16
1982	39.67	22.09	4.34	13.45	6.59	10.01	2.43	1.70	2.14	2.82	4.57	7.57	9.78
1983	7.11	23.29	43.52	16.09	0.89	1.88	0.92	1.11	1.68	0.82	4.80	28.60	10.89
1984	12.02	28.95	24.02	8.91	5.21	2.25	12.90	3.98	0.20	1.01	1.12	1.08	8.47
1985	5.70	8.21	0.96	0.79	2.56	1.22	19.94	18.93	0.46	2.04	33.68	6.98	8.46
1986	2.45	2.36	8.51	0.44	1.34	0.15	0.10	3.08	0.54	4.04	9.81	16.07	4.07
1987	42.60	23.57	24.39	3.60	1.36	3.43	0.71	1.64	16.55	1.07	6.11	6.22	10.94
1988	8.94	1.57	3.18	2.64	1.47	0.21	1.08	13.14	10.10	3.20	5.69	0.23	4.29
1989	4.14	14.64	29.45	15.02	11.41	4.07	20.91	3.54	25.55	38.64	3.23	19.11	15.81
1990	10.77	30.59	8.87	1.52	1.79	0.80	1.24	3.63	0.96	82.76	9.85	6.97	13.31
1991	10.01	10.37	43.30	12.71	32.57	4.73	5.02	43.46	0.95	1.04	1.82	6.20	14.35
1992	2.86	13.61	4.61	9.43	3.55	5.85	0.45	3.33	1.45	12.43	34.53	8.45	8.38
1993	50.23	7.93	29.26	22.93	3.26	1.52	0.71	0.54	1.38	3.25	4.71	3.05	10.73
1994	9.07	11.66	17.92	1.49	2.00	16.03	4.66	28.63	16.75	5.95	15.05	44.71	14.49
1995	20.35	48.67	9.03	1.34	2.44	13.36	1.10	17.30	0.60	12.10	9.30	1.54	11.43
1996	6.83	8.47	19.49	6.02	2.19	1.10	0.89	4.32	7.93	7.85	2.86	3.01	5.91
1997	10.32	19.22	15.67	13.19	1.30	1.64	23.66	2.13	2.32	7.92	10.29	13.19	10.07
1998	52.02	39.82	49.79	20.41	0.21	0.82	0.62	1.79	9.39	7.04	4.49	4.64	15.92
1999	14.25	4.74	3.78	7.21	3.54	2.03	1.92	0.12	6.30	1.06	1.30	0.85	3.93
2000	16.04	4.58	5.96	3.68	0.35	0.59	1.85	0.54	5.13	0.42	2.17	1.22	3.54
2001	2.57	3.06	9.84	0.90	0.47	1.95	0.56	0.06	0.52	0.21	0.16	0.23	1.71
2002	3.85	3.32	3.44	3.21	2.34	0.11	0.20	1.18	2.17	1.41	4.10	9.83	2.93
2003	3.49	15.47	40.00	22.50	11.13	5.92	12.05	7.66	3.73				
Minimum month	0.57	1.57	0.96	0.44	0.21	0.11	0.10	0.06	0.20	0.21	0.16	0.23	1.71
Median month	9.07	13.61	9.84	6.02	2.19	1.88	1.24	3.08	2.14	3.20	4.57	6.22	9.13
Average month	14.60	16.09	17.46	8.17	4.30	3.49	5.09	7.16	5.11	8.85	7.50	9.42	8.84
Maximum month	52.02	48.67	49.79	22.93	32.57	16.03	23.66	43.46	25.55	82.76	34.53	44.71	15.92

cfs = cubic feet per second

Table J-20 Average Monthly Runoff Flow for Hanging Rock Creek (cfs) (1980–2003)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	AVG
1980										5.01	6.49	8.34	
1981	8.17	19.05	11.05	8.57	4.20	2.02	1.44	4.97	1.17	1.39	2.22	12.56	6.40
1982	33.01	36.19	29.17	25.05	19.03	18.26	7.44	7.60	5.87	4.52	6.19	15.28	17.30
1983	23.18	37.89	54.64	51.28	25.27	9.67	4.04	1.95	2.38	0.88	4.89	30.17	20.52
1984	29.01	32.08	40.91	43.52	21.98	10.46	14.60	17.57	5.90	3.50	4.57	5.13	19.10
1985	7.27	15.41	12.20	7.50	4.60	2.28	9.97	13.75	3.04	1.71	19.67	32.37	10.81
1986	15.90	15.71	19.94	10.27	3.79	0.84	0.17	1.59	1.56	2.42	8.00	20.15	8.36
1987	42.88	26.82	46.67	30.36	12.38	9.15	3.26	1.52	12.87	3.80	7.72	12.19	17.47
1988	25.70	19.05	15.92	13.38	6.68	2.11	1.43	3.70	15.50	7.96	13.94	11.21	11.38
1989	16.12	14.96	40.07	46.02	33.82	10.21	18.69	12.79	19.37	34.46	18.74	31.92	24.76
1990	28.65	39.66	35.03	22.71	12.75	5.25	2.88	3.51	2.54	31.70	18.38	19.74	18.57
1991	24.09	24.96	32.25	35.13	34.81	15.04	9.46	34.18	12.92	9.70	10.50	10.12	21.10
1992	15.98	20.12	28.42	21.64	15.23	13.28	7.00	7.23	4.00	13.95	28.91	21.45	16.43
1993	58.12	37.64	49.38	49.50	20.16	8.43	3.04	1.74	1.52	2.52	5.74	11.64	20.79
1994	18.02	24.20	31.47	17.64	8.88	13.18	10.69	22.52	15.35	19.43	23.15	41.61	20.51
1995	44.33	57.90	45.52	17.99	8.88	13.77	7.96	6.93	6.82	12.40	17.80	14.68	21.25
1996	19.72	26.26	28.25	22.54	12.49	6.91	1.73	3.35	6.06	10.77	10.25	11.74	13.34
1997	19.94	28.14	30.26	19.88	16.39	7.62	10.32	10.21	3.42	6.44	18.07	21.26	16.00
1998	56.34	60.75	63.76	56.55	32.31	12.12	4.86	4.63	7.59	10.61	10.32	12.04	27.66
1999	25.33	25.62	18.02	13.48	14.84	4.14	2.93	0.69	1.68	5.06	3.71	3.87	9.95
2000	12.22	24.56	14.36	11.60	3.33	0.88	1.32	1.04	4.06	1.68	2.20	3.75	6.75
2001	4.94	7.99	12.17	9.20	1.66	1.78	0.64	0.35	0.32	0.36	0.58	0.32	3.36
2002	2.23	3.25	4.50	6.00	1.50	0.56	0.42	0.62	1.41	1.34	5.33	10.74	3.16
2003	10.67	25.32	49.91	37.46	17.08	12.95	18.63	16.54	5.50	3.70			
Minimum month	2.23	3.25	4.50	6.00	1.50	0.56	0.17	0.35	0.32	0.36	0.58	0.32	3.16
Median month	19.94	25.32	30.26	21.64	12.75	8.43	4.04	4.63	4.06	5.01	8.00	12.19	16.87
Average month	23.56	27.11	31.04	25.10	14.44	7.87	6.21	7.78	6.12	8.33	10.76	15.75	15.23
Maximum month	58.12	60.75	63.76	56.55	34.81	18.26	18.69	34.18	19.37	34.46	28.91	41.61	27.66

cfs = cubic feet per second

The distribution of daily flows within each month for total flow, baseflow, and runoff flow are shown in Figure J-5, Figure J-6, and Figure J-7, respectively. Over this 23 year period of record, runoff flows are generally more variable than baseflows. Although the ranges of flows are fairly similar with daily runoff flows ranging from 0 cfs to nearly 100 cfs and daily baseflows ranging from 0.5 cfs to nearly 100 cfs, the interquartile range is greater for the runoff flows compared to the baseflows. With respect to season, the baseflow distributions are more variable, with lower baseflows occurring in the summer months and higher baseflows occurring in the winter months. For the runoff component, the spectrum of observed flows is similar from month to month. Because total flows are primarily comprised of the baseflow component, the distribution of total flow more closely matches that of the baseflow distribution.

J.3.2 Little Fork Creek Gage

From 1990 to 2012, the USGS maintained a stream gage (USGS Gage 02131320) along Little Fork Creek in Jefferson, South Carolina, approximately 9 miles from the Project area at the following coordinates: 34.636944, 80.406389. (In addition, USGS operated a gage in nearby Little Fork Creek [USGS Gage 02131320] from 1990 to 2001 and from 2008 to 2012. This gage provides an indication of relative flow conditions that correspond with Haile's more recent data collection efforts.) The drainage area for the watershed at this gage is 15.0 square miles. Daily discharge data are available from October 1990 to December 2012, and gage height data are available from May 1990 to December 2012. There is a gap in the period of record from 2001 to 2008.

Flow data reported by the USGS are provided in Figure J-8 and Figure J-9, which show the mean daily flow and annual peak flows, respectively. The Little Fork Creek flow information is shown because monitoring at the Hanging Rock Creek gage has been discontinued, and this gage is the closest active gage which can provide estimates of flows on ungaged streams in the study area. Average annual baseflow contributions are within 6 percent when comparing the data from these two gages.

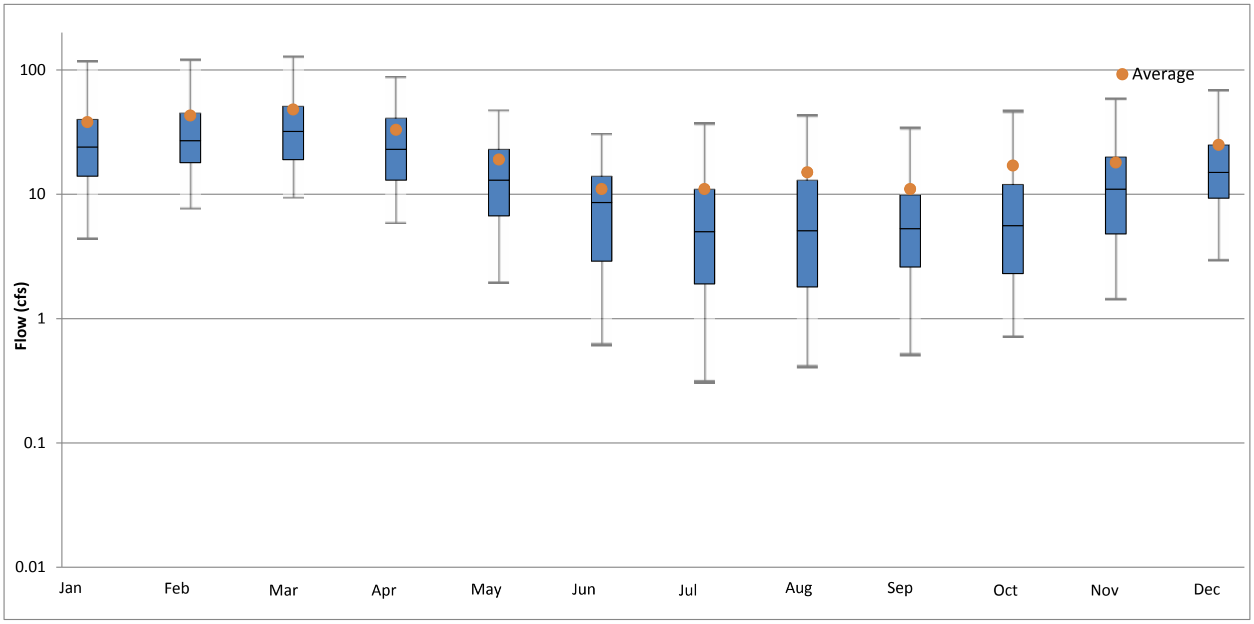

Figure J-5 Distribution of Daily Total Flows by Month for the Hanging Rock Creek Gage

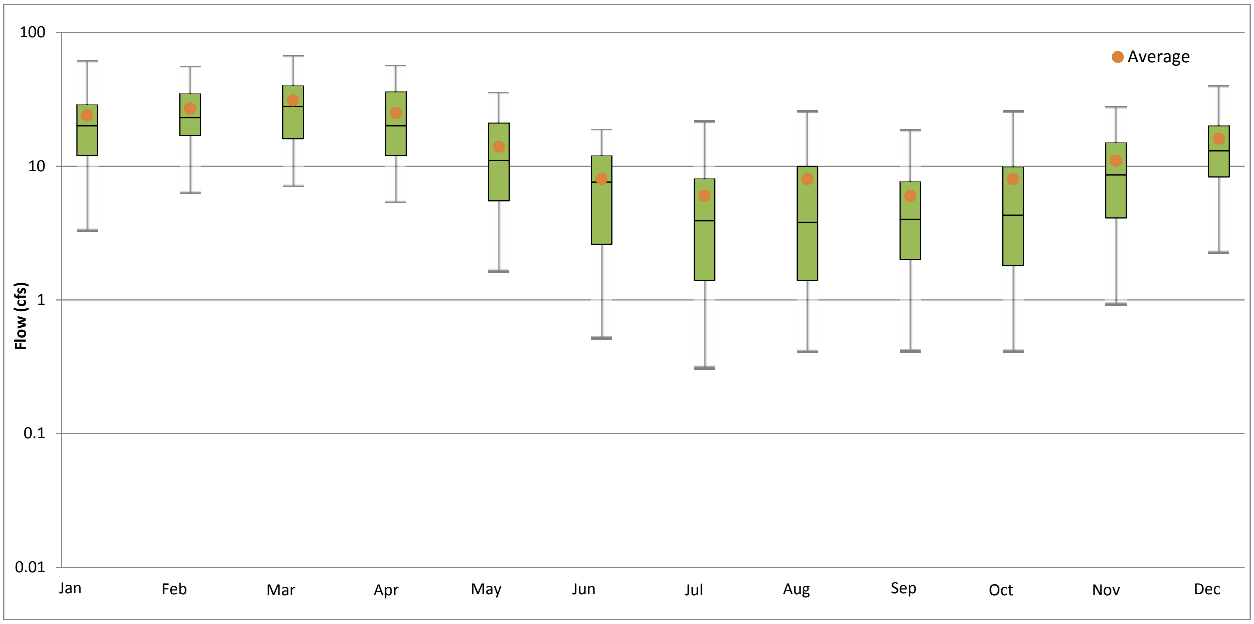

Figure J-6 Distribution of Daily Baseflows by Month for the Hanging Rock Creek Gage

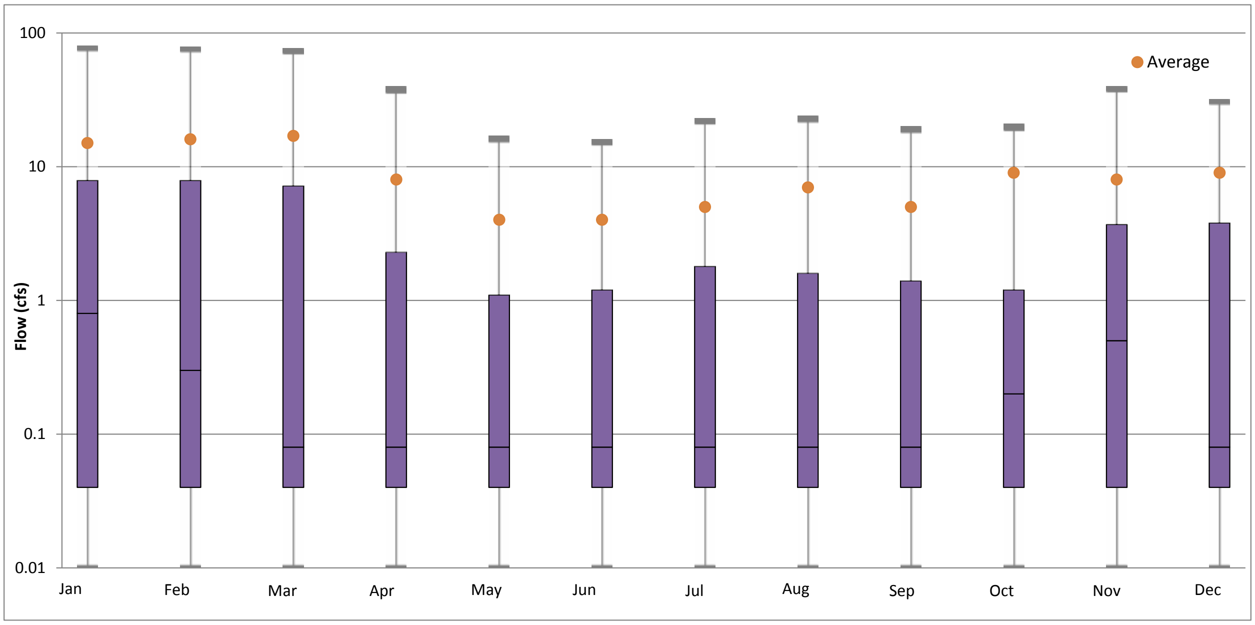

Figure J-7 Distribution of Daily Runoff Flows by Month for the Hanging Rock Creek Gage

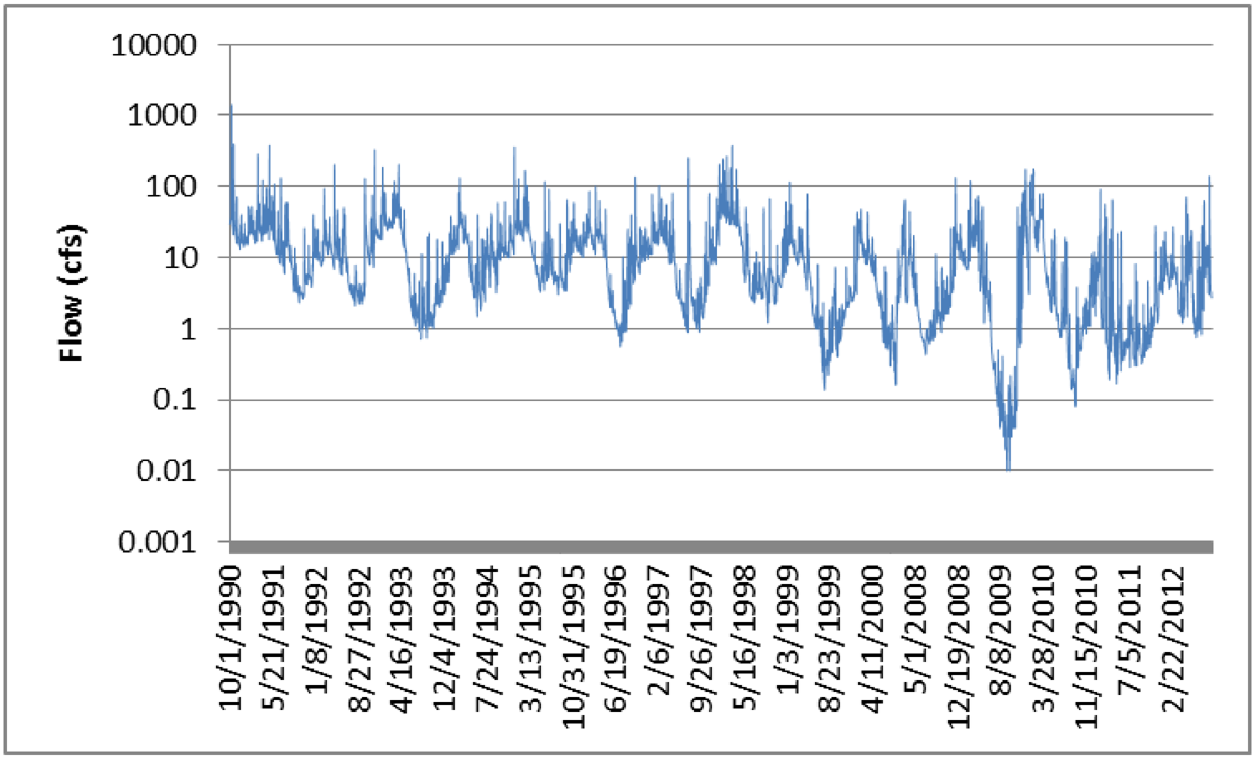

Figure J-8 Mean Daily Flow at the Little Fork Creek Gage (1990–2001 and 2008–2012)

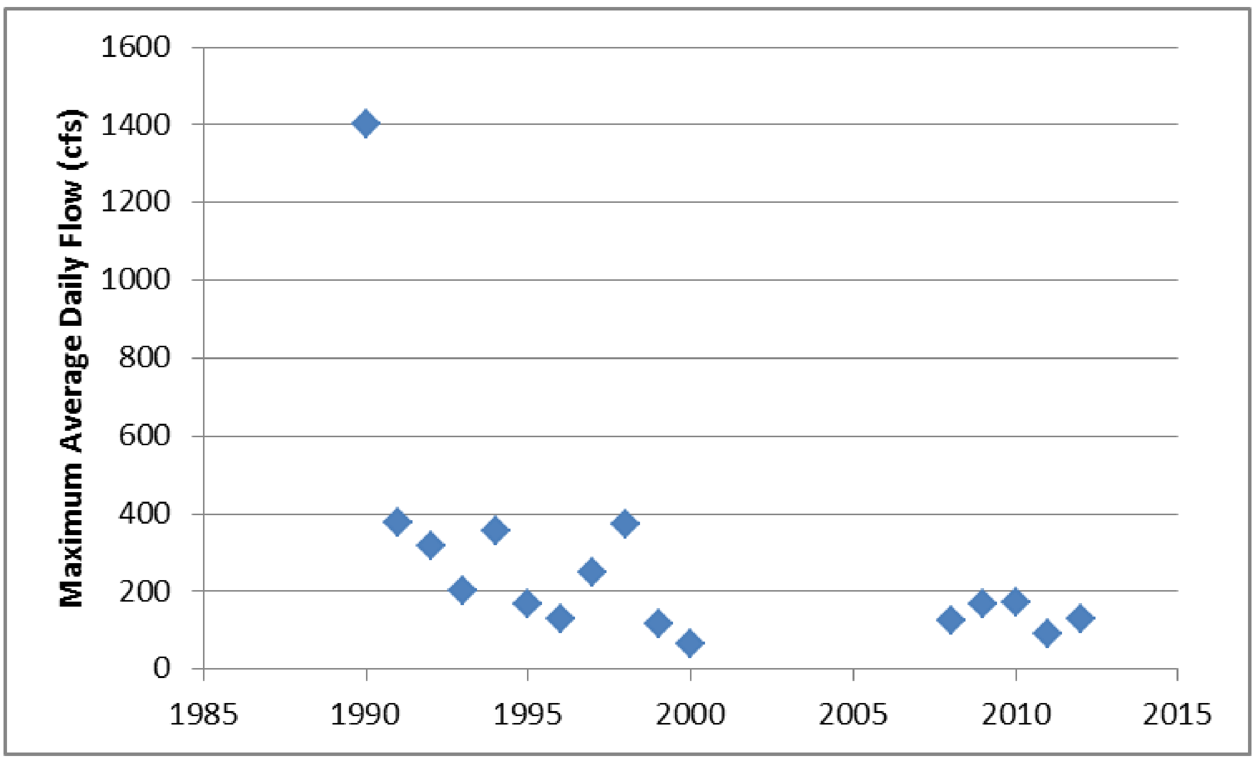

Figure J-9 Annual Peak Flow at the Little Fork Creek Gage (1990–2001 and 2008–2012)

J.4 Water Quality Data

Haile provided a water quality database in November 2012 that includes field parameters, nutrients, metals, and general chemistry (Haile 2012a). The tables in this section provide summary statistics for these data, presented by sampling station. Table J-21 includes site IDs and descriptions for the surface water sampling stations; these stations are shown in Figure J-10. Three of the stations in the study area are upstream of previous mining activities (SW-15, SW-16, and SW-17). These stations are referred to as "baseline stations" in this appendix, and they are used to compare to water quality conditions at stations that have been impacted in the past by mining activities. The site IDs for these stations are footnoted in the tables to facilitate comparison of the baseline stations to the other stations in the study area.

Table J-21 Surface Water Sampling Station Descriptions

Site ID	Sampling Station Description
SW-01	Haile Gold Mine Creek
SW-01A	Haile Gold Mine Creek
SW-01B	Haile Gold Mine Creek
SW-02	Haile Gold Mine Creek
SW-04	Haile Gold Mine Creek tributary northwest of mine area near Project boundary
SW-05	Haile Gold Mine Creek tributary northwest of mine area
SW-07	Haile Gold Mine Creek
SW-08	Haile Gold Mine Creek
SW-09	Haile Gold Mine Creek just upstream of Little Lynches River
SW-11	Haile Gold Mine Creek
SW-12	Little Lynches River downstream of Camp Branch Creek
SW-12A	Little Lynches River immediately upstream of Haile Gold Mine Creek
SW-13	Little Lynches River downstream of Unnamed Tributary southeast of Project boundary
SW-14	Unnamed Tributary southeast of Project boundary
SW-15	Little Lynches River upstream of Camp Branch Creek[a]
SW-16	Upstream Camp Branch Creek[a]
SW-17	Upstream Camp Branch Creek[a]
SW-18	Upstream Haile Gold Mine Creek, northeast fork
SW-19	Upstream Haile Gold Mine Creek, northwest fork
SW-20	Small tributary to Haile Gold Mine Creek downstream of mine area

[a] Denotes sites that are most representative of baseline conditions (i.e., not affected by previous mining activities). These sites are referred to as "baseline sites" in the following discussions.

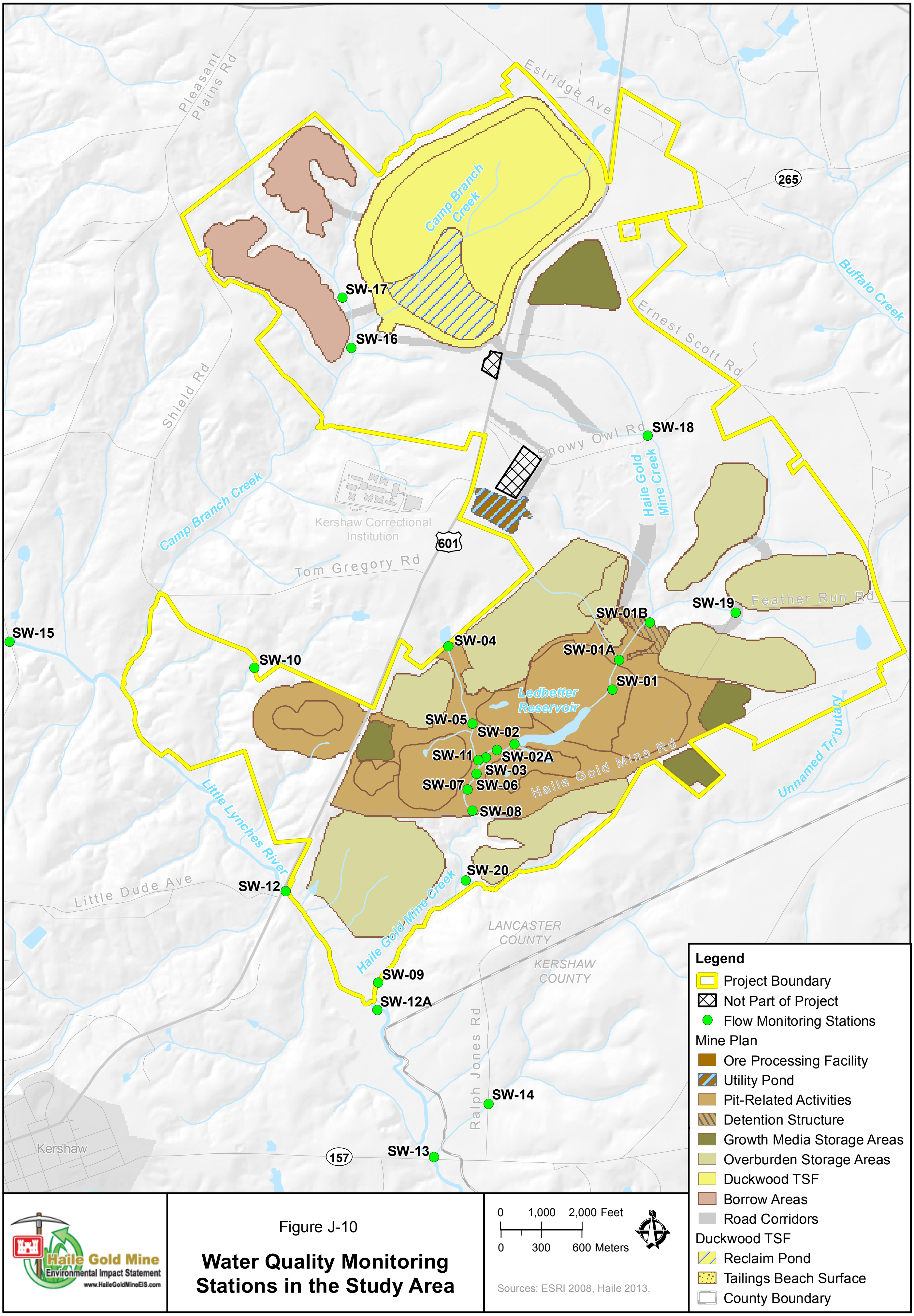

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Figure J-10

Water Quality Monitoring Stations in the Study Area

Sources: ESRI 2008, Haile 2013.

J.4.2 Field Parameters

This section describes the field parameters observed in the study area primarily from 2008 to 2012, including pH, dissolved oxygen (DO), turbidity, and temperature.

J.4.2.1 pH

Table J-21 shows the range of pH observed at sampling sites upstream, downstream, and within the mining site. Monitoring data at sites on the Little Lynches River upstream of Haile Gold Mine Creek (SW-15, SW-12, and SW-12A) are within State limits typically to the 5th percentile of measured values. The majority of pH values measured within the Project boundary and in Upper Camp Branch Creek were less than the State water quality standard of 6.0. Even the pH measurements in the Unnamed Tributary southeast of the Project boundary, which is outside of the historical mining area, typically were lower than the standard. The pH of the Little Lynches River downstream of the confluence of Haile Gold Mine Creek (SW-13) is slightly lower than those sites upstream of the confluence, reflecting the impact of those lower pH waters from Haile Gold Mine Creek on the river. Haile Gold Mine Creek was previously listed as impaired for aquatic life use due to low pH levels; this waterbody was removed from the State's Section 303(d) list of impaired waters in 2004 because the State deemed the low pH due to natural conditions based on an assessment performed by Water Management Consultants (2003).

J.4.2.2 Temperature

Table J-22 and Table J-23 summarize the temperature measurements collected in the study area from 2009 to 2012. In general, the temperature data are sparse. For many of the stations, only zero or one sample was collected in a given month over the 3-year record. Monitoring data indicate higher water temperatures in July and August, and lower temperatures in January and December. Water temperatures throughout the study area showed little spatial variability among the monthly average temperatures.

Table J-21 pH Levels Observed in Surface Waters in the Study Area (2008–2012)

Site ID	n	pct ND (%)	Percentile						
			5	10	25	50	75	90	95
SW-01	0								
SW-01A	16	0	***3.79***	***3.89***	***4.01***	***4.24***	***4.57***	***4.67***	***4.97***
SW-01B	21	0	***3.57***	***3.76***	***3.81***	***4.20***	***4.40***	***4.59***	***4.64***
SW-02	16	0	***3.72***	***3.96***	***4.55***	***4.79***	***5.07***	***5.43***	***5.55***
SW-04	1	0				***5.16***			
SW-05	17	0	***4.85***	***4.96***	***5.31***	***5.65***	***5.76***	***5.89***	***5.98***
SW-07	1	0	***5.37***	***5.37***	***5.37***	***5.37***	***5.37***	***5.37***	***5.37***
SW-08	18	0	***3.59***	***3.87***	***4.63***	***4.74***	***5.11***	***5.28***	***5.58***
SW-09	17	0	***3.44***	***3.59***	***4.03***	***4.62***	***4.75***	***5.01***	***5.11***
SW-11	17	0	***4.57***	***4.83***	***5.46***	***5.86***	6.06	6.23	6.30
SW-12	19	0	***5.89***	6.03	6.29	6.56	6.72	6.85	6.88
SW-12A	22	0	6.11	6.24	6.36	6.51	6.71	6.91	6.93
SW-13	17	0	***5.69***	***5.72***	***5.81***	6.24	6.63	6.74	6.81
SW-14	16	0	***4.69***	***5.01***	***5.27***	***5.37***	***5.71***	***5.91***	***5.98***
SW-15	15	0	6.09	6.10	6.37	6.45	6.79	6.84	6.91
SW-16	13	0	***4.98***	***4.98***	***5.03***	***5.12***	***5.16***	***5.27***	***5.49***
SW-17	17	0	***4.71***	***4.72***	***4.97***	***5.57***	***5.76***	***5.97***	6.02
SW-18	14	0	***3.60***	***3.64***	***3.79***	***3.90***	***4.01***	***4.11***	***4.15***
SW-19	14	0	***3.59***	***3.67***	***3.75***	***3.87***	***4.17***	***4.24***	***4.27***
SW-20	10	0	***5.31***	***5.37***	***5.85***	***5.99***	6.08	6.10	6.12

Notes:

n = number of samples
pct ND = percent non-detect

Numbers in bold-faced, italicized font indicate that the value is outside of the range of water quality standards.
SW-15, SW-16, and SW-17 are the baseline sites.

A blank cell corresponds to a “0” number of samples, indicating that no samples were taken at the station. If only one sample was collected, the measured value is placed in the 50th percentile column, and the other columns are blank.

Table J-22 Number of Surface Water Temperature Measurements in the Study Area (2009–2012)

Site ID	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
SW-01A	3		1	4			3			3		
SW-01B	2	1	1	4		1	3	1		3	1	1
SW-02	3		1	4			3			3		
SW-05	2	1	1	4			2			3	1	1
SW-07				1								
SW-08	3		1	4			3			3	1	1
SW-09	3		1	4			3			3	1	1
SW-11	3		1	4			2			3	1	1
SW-12	1	1	1	4			4			3	1	1
SW-12A	3		1	4		1	4	1		3	1	
SW-13	2		1	4			3			3	1	1
SW-14	1	2	1	1	1	1	1	1	1	2	2	2
SW-15	1	2	1		1	1	1	1	1	2	2	2
SW-16	1	2	1	1					1	2	2	2
SW-17	1	2	1	1	2	1		1	2	2	2	2
SW-18	1	2	1	2					2	2	2	2
SW-19	1	2	1	2					2	2	2	2
SW-20	1	2	1	1						1	2	2

Note:

SW-15, SW-16, and SW-17 are the baseline sites.

Table J-23 Average Surface Water Temperature Measurements in the Study Area (°C)

Site ID	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
SW-01A	7.7		9.0	14.9			20.0			16.4		
SW-01B	7.1	8.2	8.9	15.4		19.2	21.6	21.9		16.4	11.5	9.9
SW-02	6.8		10.7	18.0			29.8			19.1		
SW-05	7.0	10.0	11.5	17.3			22.5			18.0	11.6	9.0
SW-07				18.7								
SW-08	7.3		9.1	17.9			26.5			18.3	11.1	8.2
SW-09	8.6		8.3	17.1			25.0			16.4	10.8	9.6
SW-11	9.2		12.3	18.3			24.2			17.9	11.6	8.8
SW-12	5.4	6.3	8.2	15.1			24.8			17.1	7.3	9.5
SW-12A	7.3		6.3	14.7		20.5	24.1	24.0		15.4	8.4	
SW-13	9.3		5.5	15.1			23.0			15.8	9.4	7.5
SW-14	6.4	10.6	14.3	14.8	19.3	23.1	24.0	22.3	19.7	16.1	11.4	7.1
SW-15	4.8	9.4	14.2		20.8	24.2	25.1	25.5	20.2	17.2	8.9	6.0
SW-16	4.2	10.7	18.1	21.8					14.9	15.3	11.8	8.3
SW-17	3.4	11.8	13.7	25.0	26.6	22.4		23.0	20.9	16.3	10.5	7.9
SW-18	5.9	10.7	15.3	21.4					14.7	17.2	13.7	9.0
SW-19	7.3	10.8	15.3	16.6					19.8	16.9	13.9	9.5
SW-20	4.0	10.0	15.0	13.8						17.3	12.9	8.3

Note:

SW-15, SW-16, and SW-17 are the baseline sites.

J.4.2.3 Dissolved Oxygen

Maintaining sufficient dissolved oxygen (DO) levels in surface waters is essential to support a healthy ecosystem. Throughout the sampling stations in the study area, DO levels in the 50th to 95th percentile typically met the State water quality standard (daily average not less than 5.0 milligrams per liter [mg/L], with a low of 4.0 mg/L) (Table J-24). DO observations in Little Lynches River upstream of Camp Branch Creek (SW-15) are higher than the minimum instantaneous standard of 4 mg/L and are generally greater than the minimum mean daily value of 5 mg/L. The high values observed at SW-15 are likely data entry errors where the percent saturation was entered rather than the concentration.

Locations along the Little Lynches River between Camp Branch Creek and the Unnamed Tributary southeast of the Project boundary have relatively low DO concentrations. In Upper Camp Branch Creek (SW-16 and SW-17), DO concentrations are typically higher than the minimum standards, with hypoxic concentrations (DO less than 2 mg/L, which is the level needed to sustain most animal life) observed in 10 percent of the samples at SW-17. Water quality data were not collected in Lower Camp Branch Creek downstream of the Project boundary. The lower percentile DO concentrations in Lower Haile Gold Mine Creek (SW-09 and SW-20) were generally higher than those observed in the headwaters (SW-18 and SW-19). In the samples at SW-16 (Upper Camp Branch Creek) and SW-18 (Upper Haile Gold Mine Creek), the higher percentile DO concentrations are in excess of 20 mg/L and are indicative of high DO production from aquatic plants and algae. High DO production may also result in low DO concentrations once the organic material dies and begins to decay, which may explain some of the low DO concentrations observed in the system.

J.4.2.4 Turbidity

Land use activities that alter the natural landscape have the potential to increase the amount of sediment in surface waters. Turbidity provides an indication of the amount of material suspended in the water, and a limit of 50 NTU (nephelometric turbidity units) has been established by the State (SCDHEC 2012). There is little observed variability in turbidity levels in waters throughout the study area (Table J-25). Median turbidity levels are typically less than 10 NTU. The highest turbidity levels were observed at station SW-17 (Upper Camp Branch Creek), where concentrations at the 95th percentile were 35.5 NTU, still well below the State standard of 50 NTU. In Haile Gold Mine Creek, turbidity values generally increased from upstream to downstream. Turbidity levels were generally consistent throughout the Little Lynches River, with the highest values observed at the most downstream location.

J.4.3 Nutrients

Nutrient enrichment from runoff and groundwater has the potential to increase the flora in streams. When the increased biomass dies, it can settle in the water column and decay. The decomposition process consumes DO and may reduce DO concentrations to the point where biota cannot survive. In addition, ammonia may be directly toxic to some aquatic organisms. Toxicity levels of ammonia are driven by the pH of the water, as indicated in Section 3.4 of the EIS and by the South Carolina Department of Health and Environmental Control (SCDHEC) (2012).

For streams, the SCDHEC (2012) prescribes narrative nutrient criteria. To assess the relative conditions of the streams in the study area, nutrient concentrations were evaluated with respect to the baseline locations, including Little Lynches River upstream of Camp Branch Creek (SW-15) and Upper Camp Branch Creek (SW-16 and SW-17). Nutrient concentrations at SW-14 are generally higher than the other stations in the study area. Based on satellite imagery, there appears to be a confined animal operation in the unnamed tributary southeast of the project boundary.

Table J-24 Dissolved Oxygen Levels Observed in Surface Waters in the Study Area (mg/L) (2008–2012)

Site ID	n	pct ND (%)	Percentile						
			5	10	25	50	75	90	95
SW-01	0								
SW-01A	5	0	***3.52***	***4.33***	6.76	7.31	7.66	9.66	10.3
SW-01B	7	0	5.57	5.83	6.64	7.19	7.63	9.61	10.8
SW-02	4	0	***3.18***	***3.65***	5.06	6.68	7.79	8.30	8.47
SW-04	0								
SW-05	6	0	***1.68***	***2.97***	5.94	7.16	7.88	9.56	10.28
SW-07	0								
SW-08	6	0	***4.36***	***4.69***	5.65	6.57	7.50	7.83	7.84
SW-09	6	0	***4.18***	***4.99***	6.75	7.32	8.20	8.52	8.54
SW-11	5	0	***3.40***	***4.15***	6.38	6.42	7.41	8.04	8.25
SW-12	7	0	***0.20***	***0.20***	***1.20***	6.18	6.58	7.12	7.31
SW-12A	6	0	***2.01***	***2.13***	***2.35***	***2.60***	4.85	5.83	5.98
SW-13	6	0	***2.95***	***3.06***	***3.87***	6.22	7.11	7.45	7.57
SW-14	11	0	***1.39***	***2.67***	***4.87***	7.29	11.6	13.0	15.5
SW-15	11	0	***4.69***	***5.06***	5.59	7.41	29.5	49.0	50.0
SW-16	10	0	***4.27***	5.66	7.26	7.87	11.0	17.0	21.5
SW-17	14	0	***0.03***	***1.66***	6.18	8.53	11.3	12.9	13.0
SW-18	11	0	***4.39***	***4.52***	***4.92***	5.27	16.5	18.0	25.5
SW-19	11	0	***2.73***	***4.24***	***4.32***	***4.95***	11.0	12.0	12.5
SW-20	7	0	5.77	6.37	7.22	10.0	11.0	35.4	53.7

Notes:

n = number of samples

pct ND = percent non-detect

Numbers in bold-faced, italicized font indicate that the value is outside of the range of water quality standards.

SW-15, SW-16, and SW-17 are the baseline sites.

A blank cell corresponds to a “0” number of samples, indicating that no samples were taken at the station

Table J-25 Turbidity Levels Observed in Surface Waters in the Study Area (NTU) (2008–2012)

Site ID	n	pct ND (%)	Percentile						
			5	10	25	50	75	90	95
SW-01	1	0				3.70			
SW-01A	14	0	0.93	1.40	1.45	2.15	3.08	3.20	7.68
SW-01B	20	0	1.05	1.19	1.30	1.60	2.75	3.15	3.65
SW-02	13	0	0.62	1.46	3.50	6.50	11.0	11.8	12.0
SW-04	1	0				4.90			
SW-05	14	0	0.05	0.46	1.63	2.95	4.48	5.18	6.56
SW-07	0								
SW-08	15	0	0.34	0.62	4.30	5.90	7.45	10.20	11.6
SW-09	14	0	0.28	0.45	3.35	4.90	6.20	7.47	8.57
SW-11	14	0	0.99	1.77	3.20	4.05	5.88	7.68	8.40
SW-12	17	0	0.05	0.05	0.05	4.00	5.60	8.76	9.84
SW-12A	19	0	2.26	2.74	3.70	5.00	7.00	9.24	12.7
SW-13	13	0	0.05	0.88	4.20	5.20	7.70	12.9	18.8
SW-14	15	0	0.05	0.05	1.60	2.50	4.60	8.52	10.6
SW-15	14	0	1.71	2.69	4.20	6.35	7.65	10.8	32.0
SW-16	10	0	1.79	1.88	2.10	2.20	4.00	4.34	4.97
SW-17	11	0	4.25	5.30	5.90	6.30	10.9	25.0	35.5
SW-18	9	0	0.75	1.45	1.80	1.90	2.20	2.64	2.72
SW-19	9	0	1.04	1.08	1.10	1.30	1.50	2.02	2.06
SW-20	8	0	0.91	1.77	2.73	3.45	4.70	5.36	5.78

Notes:

n = number of samples
pct ND = percent non-detect

SW-15, SW-16, and SW-17 are the baseline sites.

A blank cell corresponds to a “0” number of samples, indicating that no samples were taken at the station. If only one sample was collected, the measured value is placed in the 50th percentile column, and the other columns are blank.

J.4.3.1 Ammonia

As noted, ammonia can be directly toxic to aquatic organisms and the level at which concentrations cause toxicity is dependent on the pH of the water. Because pH levels are variable throughout the study area, the discussion below summarizes the spatial variability in ammonia concentrations. Typically, ammonia concentrations in Upper Camp Branch Creek (SW-16 and SW-17) were lower than those observed in the Little Lynches River upstream of Camp Branch Creek (SW-15; Table J-26). Ammonia concentrations in Upper Haile Gold Mine Creek (SW-18 and SW-19), Lower Haile Gold Mine Creek (SW-09 and SW-20), the Unnamed Tributary southeast of the Project boundary (SW-14), and the most downstream location on the Little Lynches River (SW-13) were similar to those at the baseline stations (SW-15, SW-16, SW-17). The highest ammonia concentrations were observed in Haile Gold Mine Creek at SW-01B and SW-11, and in the Little Lynches River upstream of Haile Gold Mine Creek (SW-12A). Many samples in the study area were less than the reporting limits, which ranged from 0.03 to 0.05 mg/L for this study.

J.4.3.2 Nitrate

Like ammonia, higher nitrate concentrations were observed at the upstream Little Lynches River location (SW-15) relative to the other two background stations located on Upper Camp Branch Creek (SW-16 and SW-17) (Table J-27). The highest median and overall nitrate concentrations were observed in the Unnamed Tributary southeast of the Project boundary (SW-14) which appears to have a confined animal operation in the subwatershed based on satellite imagery. In Haile Gold Mine Creek, values were similar across all sites, except for higher values recorded at SW-18 upstream of historical mining activities. Nitrate concentrations were similar in the Little Lynches River between Camp Branch Creek and the most downstream station (SW-12, SW-12A, and SW-13); values at these stations were generally lower than the baseline station upstream of Camp Branch Creek (SW-15). All samples at all stations were below the drinking water quality standard (10 mg/L), and several were below the minimum reporting limit of 0.05 mg/L.

J.4.3.3 Nitrate plus Nitrite

Laboratory methods appear to have varied during the monitoring efforts; at times, nitrate was reported and at other times, nitrate plus nitrite were reported. Functionally, there is little difference between the two measurements because nitrite typically converts rapidly to nitrate in surface waters. The same pattern of higher concentrations in the Little Lynches River baseline site (SW-15) relative to the two Upper Camp Branch Creek sites (SW-16 and SW-17) was observed (Table J-28). Concentrations at the other Little Lynches River sites (SW-12, SW-12A, and SW-13) were lower than the upstream site. Concentrations at the Haile Gold Mine Creek sites were generally similar from upstream to downstream and were lower than the three background stations. The highest overall concentrations were observed at the Unnamed Tributary southeast of the Project boundary (SW-14) which appears to have a confined animal operation in the subwatershed based on satellite imagery. All samples at all stations were below the drinking water quality standard (1 mg/L), and several were below the minimum reporting limit of 0.05 mg/L.

Table J-26 Ammonia-N Levels Observed in Surface Waters in the Study Area (mg/L) (2008–2012)

			Percentile						
Site ID	n	pct ND (%)	5	10	25	50	75	90	95
SW-01	1	0				0.11			
SW-01A	16	38	<0.03	<0.03	<0.05	0.06	0.10	0.17	0.18
SW-01B	22	14	<0.05	<0.05	0.08	0.12	0.16	0.23	0.34
SW-02	14	21	<0.05	<0.05	0.06	0.10	0.12	0.21	0.22
SW-04	1	0				0.19			
SW-05	16	19	<0.05	<0.05	0.06	0.07	0.14	0.17	0.18
SW-07	1	100				<0.05			
SW-08	16	25	<0.05	<0.05	0.05	0.09	0.14	0.17	0.17
SW-09	16	25	<0.05	<0.05	0.04	0.08	0.10	0.12	0.17
SW-11	16	13	<0.05	0.04	0.07	0.10	0.17	0.25	0.28
SW-12	20	20	<0.05	<0.05	0.06	0.08	0.16	0.18	0.18
SW-12A	23	22	<0.05	<0.05	0.06	0.11	0.24	0.40	0.48
SW-13	16	19	<0.05	<0.05	0.06	0.08	0.10	0.12	0.13
SW-14	16	31	<0.05	<0.05	<0.05	0.08	0.10	0.10	0.11
SW-15	15	20	<0.05	<0.05	0.07	0.10	0.13	0.18	0.21
SW-16	11	36	<0.05	<0.05	<0.05	0.06	0.08	0.10	0.11
SW-17	12	25	<0.05	<0.05	0.06	0.09	0.12	0.14	0.16
SW-18	10	40	<0.05	<0.05	<0.05	0.06	0.08	0.10	0.12
SW-19	10	30	<0.05	<0.05	<0.05	0.06	0.10	0.10	0.11
SW-20	9	56	<0.05	<0.05	<0.05	<0.05	0.07	0.10	0.11

Notes:

n = number of samples

pct ND = percent non-detect

SW-15, SW-16, and SW-17 are the baseline sites.

If only one sample was collected, the measured value is placed in the 50th percentile column, and the other columns are blank.

Table J-27 Nitrate-N Levels Observed in Surface Waters in the Study Area (mg/L) (2008–2012)

Site ID	n	pct ND (%)	Percentile						
			5	10	25	50	75	90	95
SW-01	1	0				0.270			
SW-01A	16	50	<0.05	<0.05	<0.05	0.040	0.073	0.185	0.325
SW-01B	21	33	<0.05	<0.05	<0.05	0.084	0.220	0.250	0.300
SW-02	13	62	<0.05	<0.05	<0.05	<0.05	0.069	0.096	0.194
SW-04	1	100				<0.05			
SW-05	16	50	<0.05	<0.05	<0.05	<0.05	0.064	0.110	0.190
SW-07	1	0				0.097			
SW-08	15	73	<0.05	<0.05	<0.05	<0.05	0.066	0.118	0.166
SW-09	15	67	<0.05	<0.05	<0.05	<0.05	0.056	0.092	0.143
SW-11	15	47	<0.05	<0.05	<0.05	0.082	0.155	0.202	0.210
SW-12	20	10	<0.05	<0.05	<0.05	0.130	0.255	0.480	0.481
SW-12A	22	9	<0.05	<0.05	0.066	0.205	0.280	0.358	0.427
SW-13	16	6	<0.05	0.043	0.066	0.180	0.270	0.320	0.478
SW-14	16	6	<0.05	<0.05	0.096	0.400	0.738	0.935	8.750
SW-15	15	13	<0.05	<0.05	0.130	0.370	0.685	0.924	1.182
SW-16	11	64	<0.05	<0.05	<0.05	<0.05	0.067	0.400	0.425
SW-17	12	50	<0.05	<0.05	<0.05	0.051	0.149	0.265	0.365
SW-18	10	40	<0.05	<0.05	<0.05	0.078	0.215	0.428	0.599
SW-19	10	70	<0.05	<0.05	<0.05	<0.05	0.048	0.070	0.135
SW-20	8	88	<0.05	<0.05	<0.05	<0.05	0.050	0.223	0.336

Notes:

n = number of samples
pct ND = percent non-detect

SW-15, SW-16, and SW-17 are the baseline sites.

If only one sample was collected, the measured value is placed in the 50th percentile column, and the other columns are blank.

Table J-28 Nitrate/Nitrite-N Levels Observed in Surface Waters in the Study Area (mg/L) (2008–2012)

Site ID	n	pct ND (%)	Percentile						
			5	10	25	50	75	90	95
SW-01	0								
SW-01A	13	54	<0.05	<0.05	<0.05	<0.05	0.064	0.110	0.292
SW-01B	11	36	<0.05	<0.05	<0.05	0.060	0.128	0.200	0.220
SW-02	10	80	<0.05	<0.05	<0.05	<0.05	<0.05	0.081	0.210
SW-04	0								
SW-05	12	58	<0.05	<0.05	<0.05	<0.05	0.033	0.086	0.229
SW-07	1	0				0.097			
SW-08	11	91	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.063
SW-09	10	90	<0.05	<0.05	<0.05	<0.05	<0.05	0.029	0.048
SW-11	11	73	<0.05	<0.05	<0.05	<0.05	0.054	0.130	0.160
SW-12	17	12	<0.05	<0.05	<0.05	0.058	0.280	0.484	0.526
SW-12A	9	11	<0.05	<0.05	0.150	0.230	0.290	0.334	0.382
SW-13	11	0	<0.05	<0.05	0.071	0.250	0.275	0.300	0.595
SW-14	20	10	<0.05	<0.05	0.096	0.285	0.650	0.883	2.550
SW-15	17	12	<0.05	<0.05	0.200	0.400	0.670	0.906	1.108
SW-16	13	69	<0.05	<0.05	<0.05	<0.05	0.058	0.335	0.420
SW-17	14	50	<0.05	<0.05	<0.05	0.051	0.107	0.255	0.344
SW-18	12	42	<0.05	<0.05	<0.05	0.078	0.243	0.379	0.561
SW-19	12	75	<0.05	<0.05	<0.05	<0.05	0.033	0.055	0.120
SW-20	9	89	<0.05	<0.05	<0.05	<0.05	<0.05	0.190	0.320

Notes:

n = number
pct ND = percent non-detect

SW-15, SW-16, and SW-17 are the baseline sites.

A blank cell corresponds to a “0” number of samples, indicating that no samples were taken at the station. If only one sample was collected, the measured value is placed in the 50th percentile column, and the other columns are blank.

J.4.3.4 Organic Nitrogen

Total Kjeldahl nitrogen (TKN) quantifies the amount of ammonia (NH_3) and organic nitrogen in the water. The amount of organic nitrogen was therefore calculated by subtracting the ammonia concentrations from the reported TKN values (Table J-29). In three samples in the record, the TKN values were equal to, or less than, the ammonia concentrations—which would be indicative of errors in laboratory analysis or issues with minimum reporting limits. These three samples were excluded from the analysis. The pattern of organic nitrogen concentrations followed that of ammonia and nitrate, with typically higher concentrations (up to the 90th percentile) in the upstream waters of the Little Lynches River (SW-15) relative to those stations downstream (SW-12, SW-12A, and SW-13).

Organic nitrogen values fluctuated in Haile Gold Mine Creek; some stations showed patterns similar to the background stations and others had relatively high concentrations. Values in the Unnamed Tributary southeast of the Project boundary were similar to those for the Little Lynches River. The highest concentrations were observed at the most downstream station (SW-13) on the Little Lynches River. There is no State drinking water quality standard for organic nitrogen.

J.4.3.5 Total Nitrogen

Total nitrogen (TN) concentrations were calculated by summing TKN and nitrate plus nitrite observations for a given sample. Table J-30 shows 5th through 95th percentile values for TN at sampling sites upstream, downstream, and within the Project boundary. In Haile Gold Mine Creek, higher TN concentrations occurred in the most upstream sites (SW-18, SW-19, and SW-01B). Measurements in Camp Branch Creek were similar to measurements in Haile Gold Mine Creek. Elevated concentrations also were recorded at each Little Lynches River station and in the Unnamed Tributary southeast of the Project boundary.

J.4.3.6 Phosphorus

Orthophosphate (PO_4) and total phosphorus are the other macro nutrients that are needed for flora growth. The measurements of PO_4 and total phosphorus were typically below the minimum reporting limit (0.05 mg/L and 0.1 mg/L, respectively) at all sampled sites (Table J-31 and Table J-32).

There is no drinking water quality standard for PO_4 or total phosphorus. Upper percentile (90th and 95th) values of total phosphorus were variable within the study area. The highest concentrations were observed in the Little Lynches River upstream of Camp Branch Creek (SW-15), the Unnamed Tributary southeast of the Project boundary (SW-14), one of the Upper Camp Branch Creek stations (SW-17), one of the Upper Haile Gold Mine Creek stations (SW-18), and one of the Lower Haile Gold Mine Creek stations (SW-20).

Table J-29 Organic Nitrogen Levels Observed in Surface Waters in the Study Area (mg/L) (2008–2012)

Site ID	n	Count NH3 > TKNa	Percentile						
			5	10	25	50	75	90	95
SW-01	1	0				0.15			
SW-01A	14	0	0.26	0.28	0.31	0.35	0.39	0.40	0.42
SW-01B	20	1	0.21	0.23	0.31	0.36	0.50	0.65	0.99
SW-02	13	0	0.17	0.28	0.33	0.42	0.53	0.74	0.77
SW-04	1	0				3.41			
SW-05	14	0	0.17	0.19	0.29	0.31	0.35	0.37	0.45
SW-07	0	0							
SW-08	15	0	0.24	0.27	0.31	0.35	0.43	0.48	0.54
SW-09	15	0	0.22	0.25	0.27	0.33	0.39	0.57	0.72
SW-11	14	0	0.19	0.22	0.24	0.30	0.40	0.52	0.53
SW-12	17	0	0.24	0.27	0.28	0.38	0.46	0.59	0.88
SW-12A	21	1	0.05	0.07	0.29	0.32	0.43	0.67	0.89
SW-13	15	0	0.29	0.32	0.36	0.41	0.50	0.67	6.48
SW-14	14	0	0.33	0.36	0.46	0.48	0.58	0.96	1.11
SW-15	15	0	0.34	0.37	0.42	0.44	0.73	0.84	0.99
SW-16	11	0	0.28	0.30	0.34	0.39	0.49	0.60	0.70
SW-17	12	0	0.34	0.39	0.43	0.50	0.55	0.68	0.74
SW-18	10	0	0.36	0.37	0.40	0.56	0.77	0.83	1.05
SW-19	10	0	0.26	0.32	0.39	0.42	0.77	0.92	1.05
SW-20	9	1	0.08	0.17	0.22	0.27	0.29	0.35	0.35

Notes:

n = number of samples

SW-15, SW-16, and SW-17 are the baseline sites.A blank cell corresponds to a “0” number of samples, indicating that no samples were taken at the station. If only one sample was collected, the measured value is placed in the 50th percentile column, and the other columns are blank.

[a] Count NH3 > TKN is the number of samples where ammonia was greater than total Kjeldahl nitrogen, so the calculated value of organic nitrogen was excluded from the analysis.

Table J-30 Total Nitrogen Levels Observed in Surface Waters in the Study Area (mg/L) (2008–2012)

Site ID	n	pct ND (%)	Percentile						
			5	10	25	50	75	90	95
SW-01	1	0				0.53			
SW-01A	12	0	0.38	0.39	0.43	0.45	0.51	0.65	0.81
SW-01B	18	0	0.41	0.43	0.53	0.69	0.79	1.05	1.26
SW-02	11	9	0.26	0.39	0.47	0.60	0.86	1.00	1.00
SW-04	1	0				3.60			
SW-05	12	0	0.34	0.36	0.42	0.51	0.59	0.69	0.75
SW-07	0								
SW-08	12	0	0.35	0.39	0.48	0.52	0.54	0.60	0.74
SW-09	13	0	0.33	0.34	0.39	0.52	0.60	0.77	0.93
SW-11	12	0	0.31	0.34	0.40	0.55	0.72	0.80	0.94
SW-12	17	0	0.48	0.51	0.55	0.63	1.10	1.20	1.44
SW-12A	20	0	0.51	0.55	0.63	0.69	0.80	1.03	1.33
SW-13	13	0	0.44	0.46	0.55	0.74	0.89	0.97	8.59
SW-14	16	6	0.50	0.67	0.77	1.10	1.25	1.65	9.35
SW-15	15	0	0.41	0.43	0.75	1.20	1.40	1.94	2.16
SW-16	11	0	0.41	0.43	0.45	0.49	0.74	0.78	0.86
SW-17	12	0	0.48	0.49	0.53	0.60	0.68	1.16	1.25
SW-18	10	0	0.45	0.46	0.57	0.68	0.97	1.29	1.70
SW-19	10	0	0.34	0.40	0.46	0.51	0.89	1.02	1.11
SW-20	9	33	0.13	0.13	0.13	0.30	0.38	0.48	0.65

Notes:

n = number of samples

pct ND = percent non-detect

SW-15, SW-16, and SW-17 are the baseline sites.

A blank cell corresponds to a “0” number of samples, indicating that no samples were taken at the station. If only one sample was collected, the measured value is placed in the 50th percentile column, and the other columns are blank.

Table J-31 Orthophosphate Levels Observed in Surface Waters in the Study Area (mg/L) (2008–2012)

Site ID	n	pct ND (%)	Percentile						
			5	10	25	50	75	90	95
SW-01	1	100				<0.05			
SW-01A	13	92	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.039
SW-01B	18	100	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
SW-02	12	100	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
SW-04	1	100				<0.05			
SW-05	13	100	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
SW-07	1	100				<0.05			
SW-08	14	100	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
SW-09	12	100	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
SW-11	14	93	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.079
SW-12	15	73	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.059
SW-12A	17	100	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
SW-13	11	100	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
SW-14	16	75	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.042
SW-15	15	73	<0.05	<0.05	<0.05	<0.05	<0.05	0.056	0.060
SW-16	11	100	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
SW-17	12	100	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
SW-18	9	100	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
SW-19	10	100	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
SW-20	8	100	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05

Notes:

n = number of samples

pct ND = percent non-detect

SW-15, SW-16, and SW-17 are the baseline sites.

If only one sample was collected, the measured value is placed in the 50th percentile column, and the other columns are blank.

Table J-32 Phosphorus Levels Observed in Surface Waters in the Study Area (mg/L) (2008–2012)

Site ID	n	pct ND (%)	Percentile						
			5	10	25	50	75	90	95
SW-01	1	100				<0.1			
SW-01A	6	100	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
SW-01B	13	100	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
SW-02	6	100	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
SW-04	1	100				<0.1			
SW-05	7	100	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
SW-07	0								
SW-08	6	100	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
SW-09	7	100	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
SW-11	7	86	<0.1	<0.1	<0.1	<0.1	<0.1	0.21	0.33
SW-12	8	88	<0.1	<0.1	<0.1	<0.1	<0.1	0.07	0.08
SW-12A	15	100	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
SW-13	7	100	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
SW-14	6	83	<0.1	<0.1	<0.1	<0.1	<0.1	0.93	1.36
SW-15	6	83	<0.1	<0.1	<0.1	<0.1	<0.1	0.93	1.36
SW-16	6	100	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
SW-17	6	83	<0.1	<0.1	<0.1	<0.1	<0.1	1.78	2.64
SW-18	6	67	<0.1	<0.1	<0.1	<0.1	0.63	1.41	1.71
SW-19	6	100	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
SW-20	6	83	<0.1	<0.1	<0.1	<0.1	<0.1	1.83	2.71

Notes:

n = number of samples

pct ND = percent non-detect

SW-15, SW-16, and SW-17 are the baseline sites.

A blank cell corresponds to a "0" number of samples, indicating that no samples were taken at the station. If only one sample was collected, the measured value is placed in the 50th percentile column, and the other columns are blank.

J.4.4 Metals

Elevated trace metal concentrations may adversely affect aquatic life by affecting reproduction, inducing mutations, and causing direct toxicity. As such, maximum metal concentrations have been established by the State and the USEPA to protect aquatic life and drinking water supplies. These levels typically are adjusted based on the hardness of the ambient waters because hardness affects the bioavailability of the metals. In the absence of hardness data paired with the metals concentrations, a conservative hardness estimate of 25 mg/L as $CaCO_3$ (calcium carbonate) was used as specified by the SCDHEC (2012). The SCDHEC (2012) criteria for metals are expressed in terms of total recoverable metals.

J.4.4.1 Dissolved Aluminum

Aluminum is a widespread and naturally occurring element in rocks and clay minerals. Aluminum levels in surface waters vary naturally according to the surrounding rock and soil compositions. The highest overall dissolved aluminum measurements were recorded in Lower Haile Gold Mine Creek (SW-09) near the confluence with the Little Lynches River, with median and 95th percentile values of 495 micrograms per liter (µg/L) and 1,375 µg/L, respectively (Table J-33). Observations of dissolved aluminum concentrations throughout the study area exceeded the secondary drinking water quality standard for total aluminum of 50 to 200 µg/L and the CCC (87 µg/L). Two stations in Lower Haile Gold Mine Creek (SW-08 and SW-09) exceed the CMC (750 µg/L) in approximately ten percent of samples.. Several samples were below the minimum reporting limit of 50 µg/L.

J.4.4.2 Total Antimony

Antimony in drinking water is exclusively attributed to human activity, with higher concentrations expected in areas affected by acid mine drainage. All observations of total antimony (Table J-34) were below the minimum reporting limit, which ranged from 2.5 to 5 µg/L, and were below the drinking water quality standard (6 µg/L) and the human health consumption standards (5.6 µg/L and 640 µg/L for the consumption of water and organisms and organisms only, respectively) at all sampled sites. No freshwater aquatic life standards are listed for total antimony.

J.4.4.3 Total Arsenic

Arsenic is a widely distributed element in the Earth's crust and is introduced to surface waters through the natural dissolution of rocks and minerals. Higher concentrations are sometimes attributed to mining waste. Similar to antimony, the majority of the total arsenic observations were well below the minimum reporting limit (2.5 µg/L), and all samples were below the drinking water quality standard (10 µg/L), the CCC (150 µg/L), and the criterion maximum concentration (CMC) (340 µg/L) for total arsenic (Table J-35).

J.4.4.4 Dissolved Arsenic

The majority of the dissolved arsenic samples collected in the sampling study were below the minimum reporting limit of 2.5 µg/L (Table J-36), which is well below the water quality standard for the total fraction (10 µg/L), the CCC (150 µg/L), and the CMC (340 µg/L) for dissolved arsenic. Among the sites, there was little variability in dissolved arsenic concentrations.

Table J-33 Dissolved Aluminum Levels Observed in Surface Waters in the Study Area (µg/L) (2008–2012)

Site ID	n	pct ND (%)	Percentile						
			5	10	25	50	75	90	95
SW-01	1	0				*150*			
SW-01A	16	0	*238*	*240*	*258*	*270*	*310*	*320*	*345*
SW-01B	22	5	*172*	*210*	*233*	*255*	*288*	*340*	*388*
SW-02	14	0	*143*	*150*	*228*	*265*	*340*	*408*	*427*
SW-04	1	100				*7.5*			
SW-05	16	13	<50	<50	*64*	*82*	*98*	*120*	*190*
SW-07	1	0				*240*			
SW-08	16	0	*175*	*240*	*335*	*400*	*420*	*765*	*993*
SW-09	16	0	*165*	*200*	*313*	*495*	*570*	*1010*	*1375*
SW-11	16	38	<50	<50	<50	*59*	*90*	*130*	*203*
SW-12	20	50	<50	<50	<50	*54*	*82*	*122*	*140*
SW-12A	23	52	<50	<50	<50	<50	*105*	*174*	*243*
SW-13	16	13	<50	<50	*60*	*95*	*135*	*165*	*185*
SW-14	16	6	*86*	*104*	*135*	*155*	*170*	*190*	*270*
SW-15	15	20	<50	<50	*60*	*79*	*110*	*334*	*708*
SW-16	11	0	*140*	*160*	*195*	*240*	*270*	*280*	*410*
SW-17	12	0	*115*	*120*	*140*	*170*	*190*	*220*	*610*
SW-18	9	0	*240*	*260*	*290*	*340*	*370*	*456*	*528*
SW-19	9	0	*164*	*168*	*180*	*220*	*240*	*242*	*246*
SW-20	8	0	*82*	*82*	*94*	*100*	*118*	*149*	*160*

Notes:

n = number of samples

pct ND = percent non-detect

Numbers in bold-faced, italicized font indicate that the value is outside of the range of water quality standards.

SW-15, SW-16, and SW-17 are the baseline sites.

If only one sample was collected, the measured value is placed in the 50th percentile column, and the other columns are blank.

Table J-34 Total Antimony Levels Observed in Surface Waters in the Study Area (µg/L) (2008–2012)

Site ID	N	pct ND (%)	Percentile						
			5	10	25	50	75	90	95
SW-01	1	100				<5			
SW-01A	11	100	<2.5	<2.5	<2.5	<5	<5	<5	<5
SW-01B	20	100	<2.5	<2.5	<2.5	<5	<5	<5	<5
SW-02	10	100	<2.5	<2.5	<2.5	<5	<5	<5	<5
SW-04	1	100				<2.5			
SW-05	13	100	<2.5	<2.5	<2.5	<5	<5	<5	<5
SW-07	0								
SW-08	13	100	<2.5	<2.5	<2.5	<5	<5	<5	<5
SW-09	13	100	<2.5	<2.5	<2.5	<5	<5	<5	<5
SW-11	11	100	<2.5	<2.5	<2.5	<5	<5	<5	<5
SW-12	18	100	<2.5	<2.5	1.56	<5	<5	<5	<5
SW-12A	21	100	<2.5	<2.5	<2.5	<5	<5	<5	<5
SW-13	13	100	<2.5	<2.5	<2.5	<5	<5	<5	<5
SW-14	12	100	<5	<5	<5	<5	<5	<5	<5
SW-15	11	100	<5	<5	<5	<5	<5	<5	<5
SW-16	10	100	<5	<5	<5	<5	<5	<5	<5
SW-17	11	100	<5	<5	<5	<5	<5	<5	<5
SW-18	9	100	<5	<5	<5	<5	<5	<5	<5
SW-19	9	100	<5	<5	<5	<5	<5	<5	<5
SW-20	9	100	<5	<5	<5	<5	<5	<5	<5

Notes:

n = number of samples

pct ND = percent non-detect

SW-15, SW-16, and SW-17 are the baseline sites.

A blank cell corresponds to a “0” number of samples, indicating that no samples were taken at the station. If only one sample was collected, the measured value is placed in the 50th percentile column, and the other columns are blank.

Table J-35 Total Arsenic Levels Observed in Surface Waters in the Study Area (µg/L) (2008–2012)

Site ID	n	pct ND (%)	Percentile						
			5	10	25	50	75	90	95
SW-01	1	100				<2.5			
SW-01A	15	100	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5
SW-01B	22	100	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5
SW-02	14	100	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5
SW-04	1	0				2.50			
SW-05	15	100	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5
SW-07	0								
SW-08	16	63	<2.5	<2.5	<2.5	<2.5	3.70	4.15	4.48
SW-09	16	75	<2.5	<2.5	<2.5	<2.5	1.59	3.20	3.35
SW-11	15	60	<2.5	<2.5	<2.5	<2.5	2.85	3.72	4.42
SW-12	20	100	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5
SW-12A	23	100	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5
SW-13	16	88	<2.5	<2.5	<2.5	<2.5	<2.5	1.93	3.93
SW-14	14	79	<2.5	<2.5	<2.5	<2.5	<2.5	2.70	3.26
SW-15	13	100	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5
SW-16	10	100	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5
SW-17	12	100	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5
SW-18	9	100	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5
SW-19	9	100	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5
SW-20	9	100	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5

Notes:

n = number of samples

pct ND = percent non-detect

SW-15, SW-16, and SW-17 are the baseline sites.

A blank cell corresponds to a "0" number of samples, indicating that no samples were taken at the station. If only one sample was collected, the measured value is placed in the 50th percentile column, and the other columns are blank.

Table J-36 Dissolved Arsenic Levels Observed in Surface Waters in the Study Area (µg/L) (2008–2012)

Site ID	n	pct ND (%)	Percentile						
			5	10	25	50	75	90	95
SW-01	1	100				<2.5			
SW-01A	16	100	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5
SW-01B	22	100	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5
SW-02	14	100	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5
SW-04	1	100				<2.5			
SW-05	16	100	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5
SW-07	1	100				<2.5			
SW-08	16	75	<2.5	<2.5	<2.5	<2.5	1.74	3.50	3.70
SW-09	16	100	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5
SW-11	16	81	<2.5	<2.5	<2.5	<2.5	<2.5	2.65	3.15
SW-12	20	100	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5
SW-12A	23	100	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5
SW-13	16	94	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	1.89
SW-14	16	81	<2.5	<2.5	<2.5	<2.5	<2.5	2.60	2.88
SW-15	15	100	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5
SW-16	11	100	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5
SW-17	12	100	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5
SW-18	9	100	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5
SW-19	9	100	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5
SW-20	8	100	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5

Notes:

n = number of samples

pct ND = percent non-detect

SW-15, SW-16, and SW-17 are the baseline sites.

If only one sample was collected, the measured value is placed in the 50th percentile column, and the other columns are blank.

J.4.4.5 Total Barium

Barium is present as a trace element in metamorphosed igneous and sedimentary rocks present in the study area and can therefore be expected to occur naturally in surface waters as a byproduct of erosion. The solubility of barium also increases with decreasing pH. Observed barium concentrations were similar at the baseline and other sites in the study area (Table J-37). Although most stations sampled were above the minimum reporting limit (5 µg/L), barium concentrations at all sampled stations were below the drinking water quality standard (2,000 µg/L). No freshwater aquatic life standards are listed for total barium.

J.4.4.6 Total Beryllium

All total beryllium samples collected in the study area (Table J-38) were below the minimum reporting limit (0.5 µg/L) and below the drinking water quality standard (4 µg/L). No freshwater aquatic life standards are listed for total beryllium.

J.4.4.7 Total Cadmium

All of the total cadmium samples collected were below the minimum reporting limit (0.5 µg/L), the drinking water quality standard (5 µg/L), and the CMC (0.53 µg/L) (Table J-39). However, the minimum reporting limit (0.5 µg/L) is above the CCC (0.1 µg/L) for chronic effects on freshwater organisms.

J.4.4.8 Dissolved Cadmium

Observations of dissolved cadmium are presented in Table J-40. All samples at all sites were below the minimum reporting limit (0.5 µg/L), the drinking water quality standard for the total fraction (5 µg/L), and the CMC (0.53 µg/L). However, the minimum reporting limit is above the CCC standard (0.097 µg/L) for chronic effects on freshwater organisms.

J.4.4.9 Total Chromium (III)

At all stations sampled, total chromium (III) concentrations were below the minimum reporting limit (10 µg/L), the drinking water quality standard (100 µg/L), the CMC (580 µg/L), and the CCC (28 µg/L) (Table J-41). Samples for total chromium (III) were collected only in 2012.

J.4.4.10 Hexavalent Chromium

Hexavalent chromium (chromium IV) concentrations also were monitored only in 2012. At the stations sampled, all were below the minimum reporting limit (<10 µg/L for the majority of the samples), the drinking water quality standard (100 µg/L), the CMC (16 µg/L), and the CCC (11 µg/L) (Table J-42). Note that samples collected in January 2012 at stations SW-09 and SW-11 had reporting limits of 100 µg/L and 1000 µg/L, respectively.

J.4.4.11 Total Chromium

All total chromium concentrations were below the minimum reporting limit (5 µg/L) and below the drinking water quality standard (100 µg/L) at all sampled sites (Table J-43). No freshwater aquatic life standards are listed for total chromium.

Table J-37 Total Barium Levels Observed in Surface Waters in the Study Area (µg/L) (2008–2012)

Site ID	n	pct ND (%)	Percentile						
			5	10	25	50	75	90	95
SW-01	1	0				10.0			
SW-01A	15	0	11.4	12.4	13.0	13.0	14.5	21.4	25.6
SW-01B	22	0	11.0	11.1	12.0	13.5	15.5	21.6	25.8
SW-02	14	0	14.0	14.3	15.0	16.5	17.8	20.0	21.4
SW-04	1	0				28.0			
SW-05	15	0	13.7	14.4	15.5	18.0	19.5	22.2	23.9
SW-07	0								
SW-08	16	0	15.0	16.0	17.0	18.0	19.3	20.5	21.0
SW-09	16	0	15.8	16.0	17.0	18.5	21.0	25.5	29.8
SW-11	15	0	17.1	18.8	20.0	21.0	26.0	28.0	31.9
SW-12	20	1	15.3	17.8	21.0	23.5	26.3	31.1	33.1
SW-12A	23	0	17.1	18.0	20.0	23.0	27.0	31.4	35.6
SW-13	16	0	18.5	19.5	21.0	22.5	24.0	26.0	26.5
SW-14	14	1	10.0	14.3	16.0	17.0	18.0	18.0	18.7
SW-15	13	0	17.2	18.8	22.0	24.0	27.0	35.8	38.2
SW-16	10	0	15.9	16.8	17.5	19.0	25.3	29.1	29.6
SW-17	12	0	15.7	17.0	18.5	20.5	25.0	27.7	28.9
SW-18	9	0	8.4	9.5	10.0	11.0	13.0	14.6	15.8
SW-19	9	0	11.0	11.0	13.0	14.0	15.0	18.2	18.6
SW-20	9	0	9.5	9.6	12.0	14.0	15.0	16.4	17.2

Notes:

n = number of samples

pct ND = percent non-detect

SW-15, SW-16, and SW-17 are the baseline sites.

A blank cell corresponds to a “0” number of samples, indicating that no samples were taken at the station. If only one sample was collected, the measured value is placed in the 50th percentile column, and the other columns are blank.

Table J-38 Total Beryllium Levels Observed in Surface Waters in the Study Area (µg/L) (2008–2012)

Site ID	n	pct ND (%)	Percentile						
			5	10	25	50	75	90	95
SW-01	1	100				<0.5			
SW-01A	15	100	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
SW-01B	22	100	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
SW-02	14	100	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
SW-04	1	100				<0.5			
SW-05	15	100	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
SW-07	0								
SW-08	16	100	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
SW-09	16	100	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
SW-11	15	100	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
SW-12	20	100	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
SW-12A	23	100	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
SW-13	16	100	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
SW-14	14	100	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
SW-15	13	100	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
SW-16	10	100	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
SW-17	12	100	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
SW-18	9	100	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
SW-19	9	100	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
SW-20	9	100	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5

Notes:

n = number of samples

pct ND = percent non-detect

SW-15, SW-16, and SW-17 are the baseline sites.

A blank cell corresponds to a “0” number of samples, indicating that no samples were taken at the station. If only one sample was collected, the measured value is placed in the 50th percentile column, and the other columns are blank.

Table J-39 Total Cadmium Levels Observed in Surface Waters in the Study Area (µg/L) (2008–2012)

Site ID	n	pct ND (%)	Percentile						
			5	10	25	50	75	90	95
SW-01	1	100				<0.5			
SW-01A	15	100	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
SW-01B	22	100	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
SW-02	14	100	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
SW-04	1	100				<0.5			
SW-05	15	100	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
SW-07	0								
SW-08	16	100	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
SW-09	16	100	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
SW-11	15	100	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
SW-12	20	100	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
SW-12A	23	100	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
SW-13	16	100	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
SW-14	13	100	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
SW-15	12	100	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
SW-16	10	100	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
SW-17	12	100	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
SW-18	9	100	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
SW-19	9	100	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
SW-20	9	100	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5

Notes:

n = number of samples

pct ND = percent non-detect

SW-15, SW-16, and SW-17 are the baseline sites.

A blank cell corresponds to a "0" number of samples, indicating that no samples were taken at the station. If only one sample was collected, the measured value is placed in the 50th percentile column, and the other columns are blank.

Table J-40 Dissolved Cadmium Levels Observed in Surface Waters in the Study Area (µg/L) (2008–2012)

Site ID	n	pct ND (%)	Percentile						
			5	10	25	50	75	90	95
SW-01	1	100				<0.5			
SW-01A	16	100	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
SW-01B	22	95	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
SW-02	14	100	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
SW-04	1	100				<0.5			
SW-05	16	100	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
SW-07	1	100				<0.5			
SW-08	16	100	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
SW-09	16	100	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
SW-11	16	100	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
SW-12	20	100	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
SW-12A	23	100	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
SW-13	16	100	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
SW-14	16	100	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
SW-15	15	100	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
SW-16	11	100	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
SW-17	12	100	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
SW-18	9	100	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
SW-19	9	100	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
SW-20	8	100	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5

Notes:

n = number of samples

pct ND = percent non-detect

SW-15, SW-16, and SW-17 are the baseline sites.

If only one sample was collected, the measured value is placed in the 50th percentile column, and the other columns are blank.

Table J-41 Total Chromium (III) Levels Observed in Surface Waters in the Study Area (µg/L) (2012)

Site ID	n	pct ND (%)	Percentile						
			5	10	25	50	75	90	95
SW-01	0								
SW-01A	3	100	<10	<10	<10	<10	<10	<10	<10
SW-01B	3	100	<10	<10	<10	<10	<10	<10	<10
SW-02	3	100	<10	<10	<10	<10	<10	<10	<10
SW-04	0								
SW-05	3	100	<10	<10	<10	<10	<10	<10	<10
SW-07	0								
SW-08	3	100	<10	<10	<10	<10	<10	<10	<10
SW-09	3	100	<10	<10	<10	<10	<10	<10	<10
SW-11	3	100	<10	<10	<10	<10	<10	<10	<10
SW-12	6	100	<10	<10	<10	<10	<10	<10	<10
SW-12A	2	100			<10	<10	<10	<10	<10
SW-13	3	100	<10	<10	<10	<10	<10	<10	<10
SW-14	4	100	<10	<10	<10	<10	<10	<10	<10
SW-15	3	100	<10	<10	<10	<10	<10	<10	<10
SW-16	3	100	<10	<10	<10	<10	<10	<10	<10
SW-17	2	100			<10		<10		
SW-18	2	100			<10		<10		
SW-19	2	100			<10		<10		
SW-20	1	100				<10			

Notes:

n = number of samples

pct ND = percent non-detect

SW-15, SW-16, and SW-17 are the baseline sites.

A blank cell corresponds to a “0” number of samples, indicating that no samples were taken at the station. If only one sample was collected, the measured value is placed in the 50th percentile column, and the other columns are blank.

Table J-42 Total Chromium (VI) Levels Observed in Surface Waters in the Study Area (µg/L) (2012)

Site ID	n	pct ND (%)	Percentile						
			5	10	25	50	75	90	95
SW-01	0								
SW-01A	1	100				<10			
SW-01B	2	100			<10		<10		
SW-02	1	100				<10			
SW-04	0								
SW-05	2	100			<10		<10		
SW-07	0								
SW-08	1	100				<10			
SW-09	2	100			<10		<100		
SW-11	2	100			<10		<1000		
SW-12	5	100	<10	<10	<10	<10	<10	<10	<10
SW-12A	0		<10	<10	<10	<10	<10	<10	<10
SW-13	1	100				<10			
SW-14	4	100	<10	<10	<10	<10	<10	<10	<10
SW-15	2	100			<10		<10		
SW-16	2	100			<10		<10		
SW-17	2	100			<10		<10		
SW-18	2	100			<10		<10		
SW-19	2	100			<10		<10		
SW-20	1	100				<10			

Notes:

n = number of samples

pct ND = percent non-detect

SW-15, SW-16, and SW-17 are the baseline sites.

A blank cell corresponds to a “0” number of samples, indicating that no samples were taken at the station. If only one sample was collected, the measured value is placed in the 50th percentile column, and the other columns are blank.

Table J-43 Total Chromium Levels Observed in Surface Waters in the Study Area (µg/L) (2012

Site ID	n	pct ND (%)	Percentile						
			5	10	25	50	75	90	95
SW-01	1	100				<5			
SW-01A	15	100	<5	<5	<5	<5	<5	<5	<5
SW-01B	22	100	<5	<5	<5	<5	<5	<5	<5
SW-02	14	100	<5	<5	<5	<5	<5	<5	<5
SW-04	1	100				<5			
SW-05	15	100	<5	<5	<5	<5	<5	<5	<5
SW-07	0								
SW-08	16	100	<5	<5	<5	<5	<5	<5	<5
SW-09	16	100	<5	<5	<5	<5	<5	<5	<5
SW-11	15	100	<5	<5	<5	<5	<5	<5	<5
SW-12	20	100	<5	<5	<5	<5	<5	<5	<5
SW-12A	23	100	<5	<5	<5	<5	<5	<5	<5
SW-13	16	100	<5	<5	<5	<5	<5	<5	<5
SW-14	13	100	<5	<5	<5	<5	<5	<5	<5
SW-15	12	100	<5	<5	<5	<5	<5	<5	<5
SW-16	10	100	<5	<5	<5	<5	<5	<5	<5
SW-17	12	100	<5	<5	<5	<5	<5	<5	<5
SW-18	9	100	<5	<5	<5	<5	<5	<5	<5
SW-19	9	100	<5	<5	<5	<5	<5	<5	<5
SW-20	9	100	<5	<5	<5	<5	<5	<5	<5

Notes:

n = number of samples

pct ND = percent non-detect

SW-15, SW-16, and SW-17 are the baseline sites.

A blank cell corresponds to a “0” number of samples, indicating that no samples were taken at the station. If only one sample was collected, the measured value is placed in the 50th percentile column, and the other columns are blank.

J.4.4.12 Total Copper

The majority of total copper samples were below the minimum reporting limit (5 µg/L) at the baseline and other sites in the study area (Table J-44). However, the minimum reporting limit is greater than the aquatic life standards. For samples above the minimum reporting limit, such as those at stations SW-08, SW-09, SW-11, and SW-19 along Haile Gold Mine Creek, the observed concentrations were above the baseline total copper levels and in excess of the CCC (2.9 µg/L). Four of these stations also had observations above the CMC (3.8 µg/L). The federal drinking water standard and the human health standard for consumption of water plus organisms are both 1,300 µg/L. No observations exceeded these human risk standards.

J.4.4.13 Dissolved Copper

Like total copper, the majority of dissolved copper samples were below the minimum reporting limit (5 µg/L) at the baseline and other sites in the study area (Table J-45). However, the minimum detection limit is greater than the drinking water standard for the total fraction (1.3 µg/L). The highest dissolved copper concentrations were found along the Little Lynches River upstream of Haile Gold Mine Creek (SW-12A) and farther downstream of the Project boundary at SW-13. Samples at three sites exceeded the CCC (2.7 µg/L) and the CMC (3.6 µg/L).

J.4.4.14 Fluoride

Total fluoride concentrations were below the minimum reporting limits (which ranged from 200 to 1,000 µg/L) and the drinking water quality standard (4000 µg/L) for all samples at all sites (Table J-46). There are no State freshwater aquatic life standards for fluoride. Samples collected at SW-09, SW-12, SW-12A, and SW13 had the lower reporting limit of 200 µg/L on the March 8, 2010 sampling date.

J.4.4.15 Total Iron

Total iron concentrations exceeded the drinking water quality standard (300 µg/L) at nearly all stations (Table J-47). There are no State freshwater aquatic life standards for iron. Most observations at SW-02, SW-08, SW-09, and SW-11 along Haile Gold Mine Creek and at the most downstream station on the Little Lynches River (SW-13) were higher than the concentrations observed at the baseline sites. The highest total iron concentrations were observed downstream of the discharge from the active passive treatment cell (SW-11). The single samples taken at SW-12 and SW-14 were below the minimum reporting limit for iron (100 µg/L).

J.4.4.16 Total Lead

The majority of the total lead concentrations in the Little Lynches River and at the baseline sites on Camp Branch Creek were similar to those collected in Haile Gold Mine Creek as most samples were below the minimum reporting limit (1.5 µg/L) (Table J-48). The CCC standard (0.54 µg/L) was exceeded at two sites (downstream of the passive treatment cell (SW-11) and upstream of historic mining activities (SW-19), and there were no exceedances of the CMC (14 µg/L). The drinking water quality standard for total lead is zero.

Table J-44 Total Copper Levels Observed in Surface Waters in the Study Area (µg/L) (2008–2012)

Site ID	n	pct ND (%)	Percentile 5	10	25	50	75	90	95
SW-01	1	100				<5			
SW-01A	15	100	<5	<5	<5	<5	<5	<5	<5
SW-01B	22	95	<5	<5	<5	<5	<5	<5	<5
SW-02	14	100	<5	<5	<5	<5	<5	<5	<5
SW-04	1	100				<5			
SW-05	15	100	<5	<5	<5	<5	<5	<5	<5
SW-07	0								
SW-08	16	94	<5	<5	<5	<5	<5	<5	***4.28***
SW-09	16	94	<5	<5	<5	<5	<5	<5	***4.63***
SW-11	15	93	<5	<5	<5	<5	<5	<5	***9.85***
SW-12	20	95	<5	<5	<5	<5	<5	<5	***2.88***
SW-12A	23	96	<5	<5	<5	<5	<5	<5	<5
SW-13	16	100	<5	<5	<5	<5	<5	<5	<5
SW-14	14	100	<5	<5	<5	<5	<5	<5	<5
SW-15	13	92	<5	<5	<5	<5	<5	<5	***3.66***
SW-16	10	100	<5	<5	<5	<5	<5	<5	<5
SW-17	12	100	<5	<5	<5	<5	<5	<5	<5
SW-18	9	100	<5	<5	<5	<5	<5	<5	<5
SW-19	9	78	<5	<5	<5	<5	<5	***13.9***	***26.0***
SW-20	9	100	<5	<5	<5	<5	<5	<5	<5

Notes:

n = number of samples

pct ND = percent non-detect

Numbers in bold-faced, italicized font indicate that the value is outside of the range of water quality standards.

SW-15, SW-16, and SW-17 are the baseline sites.

A blank cell corresponds to a “0” number of samples, indicating that no samples were taken at the station. If only one sample was collected, the measured value is placed in the 50th percentile column, and the other columns are blank.

Table J-45 Dissolved Copper Levels Observed in Surface Waters in the Study Area (µg/L) (2008–2012)

Site ID	n	pct ND (%)	Percentile						
			5	10	25	50	75	90	95
SW-01	1	100				<5			
SW-01A	16	100	<5	<5	<5	<5	<5	<5	<5
SW-01B	22	100	<5	<5	<5	<5	<5	<5	<5
SW-02	14	93	<5	<5	<5	<5	<5	<5	***3.97***
SW-04	1	100				<5			
SW-05	16	100	<5	<5	<5	<5	<5	<5	<5
SW-07	1	100	<5	<5	<5	<5	<5	<5	<5
SW-08	16	100	<5	<5	<5	<5	<5	<5	<5
SW-09	16	100	<5	<5	<5	<5	<5	<5	<5
SW-11	16	100	<5	<5	<5	<5	<5	<5	<5
SW-12	20	100	<5	<5	<5	<5	<5	<5	<5
SW-12A	23	91	<5	<5	<5	<5	<5	<5	***12.0***
SW-13	16	81	<5	<5	<5	<5	<5	***8.00***	***10.8***
SW-14	16	100	<5	<5	<5	<5	<5	<5	<5
SW-15	15	100	<5	<5	<5	<5	<5	<5	<5
SW-16	11	100	<5	<5	<5	<5	<5	<5	<5
SW-17	12	100	<5	<5	<5	<5	<5	<5	<5
SW-18	9	100	<5	<5	<5	<5	<5	<5	<5
SW-19	9	100	<5	<5	<5	<5	<5	<5	<5
SW-20	8	100	<5	<5	<5	<5	<5	<5	<5

Notes:

n = number of samples

pct ND = percent non-detect

Numbers in bold-faced, italicized font indicate that the value is outside of the range of water quality standards.

SW-15, SW-16, and SW-17 are the baseline sites.

If only one sample was collected, the measured value is placed in the 50th percentile column, and the other columns are blank.

Table J-46 Fluoride Levels Observed in Surface Waters in the Study Area (µg/L) (2008–2012)

Site ID	n	pct ND (%)	Percentile 5	10	25	50	75	90	95
SW-01	1	100				<1000			
SW-01A	16	100	<1000	<1000	<1000	<1000	<1000	<1000	<1000
SW-01B	22	100	<1000	<1000	<1000	<1000	<1000	<1000	<1000
SW-02	14	100	<1000	<1000	<1000	<1000	<1000	<1000	<1000
SW-04	1	100				<1000			
SW-05	16	100	<1000	<1000	<1000	<1000	<1000	<1000	<1000
SW-07	1	100				<1000			
SW-08	16	100	<1000	<1000	<1000	<1000	<1000	<1000	<1000
SW-09	16	100	<1000	<1000	<1000	<1000	<1000	<1000	<1000
SW-11	16	100	<1000	<1000	<1000	<1000	<1000	<1000	<1000
SW-12	20	100	<1000	<1000	<1000	<1000	<1000	<1000	<1000
SW-12A	23	100	<1000	<1000	<1000	<1000	<1000	<1000	<1000
SW-13	16	100	<1000	<1000	<1000	<1000	<1000	<1000	<1000
SW-14	16	100	<1000	<1000	<1000	<1000	<1000	<1000	<1000
SW-15	15	100	<1000	<1000	<1000	<1000	<1000	<1000	<1000
SW-16	11	100	<1000	<1000	<1000	<1000	<1000	<1000	<1000
SW-17	12	100	<1000	<1000	<1000	<1000	<1000	<1000	<1000
SW-18	10	100	<1000	<1000	<1000	<1000	<1000	<1000	<1000
SW-19	10	100	<1000	<1000	<1000	<1000	<1000	<1000	<1000
SW-20	9	100	<1000	<1000	<1000	<1000	<1000	<1000	<1000

Notes:

n = number of samples

pct ND = percent non-detect

SW-15, SW-16, and SW-17 are the baseline sites.

If only one sample was collected, the measured value is placed in the 50th percentile column, and the other columns are blank.

Table J-47 Total Iron Levels Observed in Surface Waters in the Study Area (µg/L) (2008–2012)

Site ID	n	pct ND (%)	Percentile						
			5	10	25	50	75	90	95
SW-01	1	0				190			
SW-01A	15	0	176	204	245	270	***335***	***380***	***535***
SW-01B	22	0	140	141	173	235	288	***339***	***388***
SW-02	14	0	***895***	***1030***	***1125***	***2900***	***4350***	***5290***	***5535***
SW-04	1	0				***9500***			
SW-05	15	0	***573***	***682***	***1025***	***1500***	***2050***	***2200***	***2560***
SW-07	0								
SW-08	16	0	***1975***	***2050***	***2300***	***3400***	***6025***	***7300***	***7675***
SW-09	16	0	***873***	***1350***	***1875***	***2400***	***3375***	***4250***	***4700***
SW-11	15	0	***2870***	***3180***	***3900***	***4000***	***6900***	***9040***	***12700***
SW-12	20	5	***668***	***754***	***980***	***1400***	***1600***	***1840***	***3120***
SW-12A	23	0	***711***	***738***	***1020***	***1300***	***1550***	***1860***	***2620***
SW-13	16	0	***1105***	***1250***	***1475***	***1850***	***2075***	***2400***	***3175***
SW-14	14	7	200	289	***393***	***465***	***728***	***1310***	***1540***
SW-15	13	0	***584***	***606***	***740***	***960***	***1600***	***1680***	***1940***
SW-16	10	0	***530***	***530***	***540***	***770***	***1075***	***2000***	***5150***
SW-17	12	0	***770***	***823***	***1060***	***1500***	***2000***	***2840***	***2945***
SW-18	9	0	138	146	150	170	220	284	***332***
SW-19	9	0	148	156	180	230	***310***	***360***	***420***
SW-20	9	0	***336***	***372***	***470***	***680***	***1100***	***1240***	***1320***

Notes:

n = number of samples

pct ND = percent non-detect

Numbers in bold-faced, italicized font indicate that the value is outside of the range of water quality standards.

SW-15, SW-16, and SW-17 are the baseline sites.

A blank cell corresponds to a “0” number of samples, indicating that no samples were taken at the station. If only one sample was collected, the measured value is placed in the 50th percentile column, and the other columns are blank.

Table J-48 Total Lead Levels Observed in Surface Waters in the Study Area (µg/L) (2008–2012)

Site ID	n	pct ND (%)	Percentile						
			5	10	25	50	75	90	95
SW-01	1	100				<1.5			
SW-01A	15	100	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5
SW-01B	22	100	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5
SW-02	14	100	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5
SW-04	1	100	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5
SW-05	15	100	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5
SW-07	0								
SW-08	16	100	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5
SW-09	16	100	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5
SW-11	15	93	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	*0.97*
SW-12	20	100	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5
SW-12A	23	100	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5
SW-13	16	100	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5
SW-14	14	100	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5
SW-15	13	100	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5
SW-16	10	100	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5
SW-17	12	100	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5
SW-18	9	100	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5
SW-19	9	89	<1.5	<1.5	<1.5	<1.5	<1.5	*1.00*	*1.50*
SW-20	9	100	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5

Notes:

n = number of samples

pct ND = percent non-detect

Numbers in bold-faced, italicized font indicate that the value is outside of the range of water quality standards.

SW-15, SW-16, and SW-17 are the baseline sites.

A blank cell corresponds to a “0” number of samples, indicating that no samples were taken at the station. If only one sample was collected, the measured value is placed in the 50th percentile column, and the other columns are blank.

J.4.4.17 Dissolved Lead

Similar to total lead concentrations, dissolved lead was below the minimum reporting limit (1.5 µg/L) at all but one site (Table J-49). At site SW-17 on Upper Camp Branch Creek, one sample exceeded both the minimum reporting limit and the CCC standard (0.54 µg/L); there were no exceedances of the CMC (14 µg/L). The drinking water quality standard for total lead is zero. By default, therefore, the drinking water standard for dissolved lead is also zero.

J.4.4.18 Total Manganese

Along with lead, manganese is one of the most abundant metals on the Earth's surface. At several locations in the study area including the baseline sites, total manganese concentrations were above the drinking water quality standard of 50 µg/l (Table J-50). The highest concentrations were observed in Lower and Middle Haile Gold Mine Creek (SW-08, SW-09, and SW-11). There are no State freshwater aquatic life standards for manganese. SW-12 and SW-14 had single samples that were below the minimum reporting limit for manganese (5 µg/L).

J.4.4.19 Total Mercury

Total mercury concentrations for all samples were below the minimum reporting limit (0.2 µg/L), except for a single sample at station SW-14 along the Unnamed Tributary southeast of the Project boundary (Table J-51). All samples were below the drinking water quality standard (2 µg/L), the CMC (1.6 µg/L), and the CCC (0.91 µg/L). The minimum reporting limit is higher than the human health consumption standards (0.050 µg/L and 0.051 µg/L for the consumption of water and organisms and organisms only, respectively).

J.4.4.20 Dissolved Mercury

Dissolved mercury concentrations for all samples were below the minimum reporting limit (0.2 µg/L), the drinking water standard for total mercury (2 µg/L), the CMC (1.4 µg/L), and the CCC (0.77 µg/L) (Table J-52).

J.4.4.21 Total Nickel

Total nickel concentrations were frequently below the minimum reporting limit, which ranged from 1 to 5 µg/L for the samples collected in the study area (Table J-53). Three sampling locations on Lower Haile Gold Mine Creek (SW-08, SW-09, and SW-11) were the only stations in which all samples were above the minimum reporting limit. Concentrations of total nickel in Lower Haile Gold Mine Creek were consistently higher than those observed at the other stations. Four of the stations sampled exceeded the CCC of 16 µg/L in 5 to 10 percent of samples; none of the samples exceeded the CMC (145 µg/L). There are no drinking water standards for this parameter. No samples exceeded the human health consumption standards (610 µg/L and 4,600 µg/L for the consumption of water and organisms and organisms only, respectively).

Table J-49 Dissolved Lead Levels Observed in Surface Waters in the Study Area (µg/L) (2008–2012)

Site ID	n	pct ND (%)	Percentile						
			5	10	25	50	75	90	95
SW-01	1	100				<1.5			
SW-01A	16	100	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5
SW-01B	22	100	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5
SW-02	14	100	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5
SW-04	1	100				<1.5			
SW-05	16	100	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5
SW-07	1	100				<1.5			
SW-08	16	100	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5
SW-09	16	100	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5
SW-11	16	100	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5
SW-12	20	100	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5
SW-12A	23	96	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5
SW-13	16	100	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5
SW-14	16	100	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5
SW-15	15	100	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5
SW-16	11	100	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5
SW-17	12	92	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	*1.18*
SW-18	9	100	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5
SW-19	9	100	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5
SW-20	8	100	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5

Notes:

n = number of samples

pct ND = percent non-detect

SW-15, SW-16, and SW-17 are the baseline sites.

If only one sample was collected, the measured value is placed in the 50th percentile column, and the other columns are blank.

Table J-50 Total Manganese Levels Observed in Surface Waters in the Study Area (µg/L) (2008–2012)

Site ID	n	pct ND (%)	Percentile						
			5	10	25	50	75	90	95
SW-01	1	0				6.9			
SW-01A	15	0	13.0	13.0	13.5	17.0	20.0	23.6	30.5
SW-01B	22	0	9.1	11.0	12.0	16.0	18.8	24.0	25.0
SW-02	14	0	*89.5*	*98.1*	*130*	*140*	*160*	*257*	*260*
SW-04	1	0				*120*			
SW-05	15	0	43.5	48.8	*56.5*	*90.0*	*115.0*	*132.0*	*167.0*
SW-07	0								
SW-08	16	0	*423*	*490*	*680*	*1035*	*1625*	*3150*	*4250*
SW-09	16	0	*433*	*510*	*635*	*905*	*1525*	*3350*	*4925*
SW-11	15	0	*421*	*510*	*655*	*690*	*910*	*1332*	*1900*
SW-12	20	5	*55.2*	*60.7*	*71.8*	*110*	*255*	*402*	*851*
SW-12A	23	0	*57.8*	*65.4*	*73.0*	*130*	*250*	*356*	*523*
SW-13	16	0	*145*	*165*	*195*	*300*	*483*	*760*	*868*
SW-14	14	7	17.8	26.3	28.3	34.5	45.8	*68.7*	*105*
SW-15	13	0	33.6	40.0	*56.0*	*76.0*	*140*	*170*	*542*
SW-16	10	0	42.9	43.8	46.8	*56.0*	*64.0*	*87.2*	*92.6*
SW-17	12	0	*71.2*	*73.0*	*82.8*	*96.5*	*145*	*208*	*494*
SW-18	9	0	7.2	7.3	8.8	10.0	11.0	12.4	13.2
SW-19	9	0	8.1	9.4	11.0	13.0	16.0	18.6	19.8
SW-20	9	0	13.6	18.5	27.0	29.0	*60.0*	*70.0*	*70.0*

Notes:

n = number of samples

pct ND = percent non-detect

Numbers in bold-faced, italicized font indicate that the value is outside of the range of water quality standards.

SW-15, SW-16, and SW-17 are the baseline sites.

A blank cell corresponds to a "0" number of samples, indicating that no samples were taken at the station. If only one sample was collected, the measured value is placed in the 50th percentile column, and the other columns are blank.

Table J-51 Total Mercury Levels Observed in Surface Waters in the Study Area (µg/L) (2008–2012)

Site ID	n	pct ND (%)	Percentile						
			5	10	25	50	75	90	95
SW-01	1	100				<0.2			
SW-01A	15	100	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
SW-01B	22	100	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
SW-02	14	100	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
SW-04	1	100				<0.2			
SW-05	15	100	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
SW-07	0								
SW-08	16	100	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
SW-09	16	100	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
SW-11	15	100	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
SW-12	20	100	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
SW-12A	23	100	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
SW-13	16	100	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
SW-14	14	93	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	0.24
SW-15	13	100	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
SW-16	10	100	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
SW-17	12	100	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
SW-18	9	100	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
SW-19	9	100	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
SW-20	9	100	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2

Notes:

n = number of samples

pct ND = percent non-detect

SW-15, SW-16, and SW-17 are the baseline sites.

A blank cell corresponds to a “0” number of samples, indicating that no samples were taken at the station. If only one sample was collected, the measured value is placed in the 50th percentile column, and the other columns are blank.

Table J-52 Dissolved Mercury Levels Observed in Surface Waters in the Study Area (µg/L) (2008–2012)

Site ID	n	pct ND (%)	Percentile						
			5	10	25	50	75	90	95
SW-01	1	100				<0.2			
SW-01A	16	100	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
SW-01B	22	100	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
SW-02	14	100	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
SW-04	1	100				<0.2			
SW-05	16	100	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
SW-07	1	100	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
SW-08	16	100	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
SW-09	16	100	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
SW-11	16	100	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
SW-12	20	100	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
SW-12A	21	100	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
SW-13	16	100	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
SW-14	16	100	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
SW-15	15	100	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
SW-16	11	100	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
SW-17	12	100	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
SW-18	9	100	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
SW-19	9	100	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
SW-20	8	100	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2

Notes:

n = number of samples

pct ND = percent non-detect

SW-15, SW-16, and SW-17 are the baseline sites.

If only one sample was collected, the measured value is placed in the 50th percentile column, and the other columns are blank.

Table J-53 Total Nickel Levels Observed in Surface Waters in the Study Area (µg/L) (2008–2012)

Site ID	n	pct ND (%)	Percentile						
			5	10	25	50	75	90	95
SW-01	1	100				<2			
SW-01A	15	93	<1	<1	<2	<5	<5	<5	<5
SW-01B	22	95	<1	<1	<1	<2	<5	<5	<5
SW-02	14	64	1.86	2.12	<5	<5	<5	2.64	3.09
SW-04	1	100				<1			
SW-05	15	67	1.49	1.82	2.15	<5	<5	<5	2.98
SW-07	0								
SW-08	16	0	5.43	5.75	7.30	12.0	14.8	***25.0***	***31.8***
SW-09	16	0	6.60	6.90	7.68	10.4	14.3	***26.5***	***37.8***
SW-11	15	0	5.71	6.40	7.60	8.20	9.45	13.80	***18.9***
SW-12	20	90	<1	<1	1.15	<5	<5	<5	<5
SW-12A	23	91	<1	<1	<1	<2	<5	<5	<5
SW-13	16	56	1.95	2.15	<5	<5	2.53	4.00	5.60
SW-14	14	100	<5	<5	<5	<5	<5	<5	<5
SW-15	13	100	<5	<5	<5	<5	<5	<5	<5
SW-16	10	100	<5	<5	<5	<5	<5	<5	<5
SW-17	12	100	<5	<5	<5	<5	<5	<5	<5
SW-18	9	100	<5	<5	<5	<5	<5	<5	<5
SW-19	9	89	<5	<5	<5	<5	<5	13.2	***34.6***
SW-20	9	100	<5	<5	<5	<5	<5	<5	<5

Notes:

n = number of samples

pct ND = percent non-detect

Numbers in bold-faced, italicized font indicate that the value is outside of the range of water quality standards.

SW-15, SW-16, and SW-17 are the baseline sites.

A blank cell corresponds to a “0” number of samples, indicating that no samples were taken at the station. If only one sample was collected, the measured value is placed in the 50th percentile column, and the other columns are blank.

J.4.4.22 Dissolved Nickel

Dissolved nickel concentrations were frequently below the minimum reporting limit, which ranged from 1 to 5 µg/L for the samples collected in the study area (Table J-54). Three sampling locations on Lower Haile Gold Mine Creek (SW-08, SW-09, and SW-11) were the only stations in which the majority of the samples were above the minimum reporting limit. At these sites, the highest concentrations of dissolved nickel exceeded the CCC (16 µg/L) but did not exceed the CMC (145 µg/L). There are no drinking water standards for this parameter.

J.4.4.23 Total Selenium

Total selenium concentrations for all samples were below the minimum reporting limit (2.5 µg/L), except for a single sample at station SW-11 which is downstream of the active passive treatment cells (Table J-55). All samples were below the drinking water quality standard (50 µg/L), human health consumption standards (170 µg/L and 4,200 µg/L for the consumption of water and organisms and organisms only, respectively), and the CCC (5 µg/L).

J.4.4.24 Total Silver

Total silver concentrations at all sampling stations were below the minimum reporting limit (1 µg/L) and the drinking water standard (100 µg/L) (Table J-56). However, the minimum reporting limit is above the CMC (0.37 µg/L); there is no chronic silver standard..

J.4.4.25 Total Thallium

All samples of total thallium concentrations were below the minimum reporting limit (1 µg/L) and the drinking water quality standard (2 µg/L) (Table J-57). There are no freshwater aquatic life standards for this parameter. The minimum reporting limit is greater than the human health consumption standards (0.24 µg/L and 0.47 µg/L for the consumption of water and organisms and organisms only, respectively).

J.4.4.26 Total Zinc

The majority of total zinc samples collected in the study area were less than the minimum reporting limit of 20 µg/L. At six stations in the study area, including one baseline station (SW-15), exceedance of the CCC and CMC standard for exposure of freshwater aquatic organisms (which are both 37 µg/l) were observed (Table J-58). None of the samples exceeded the secondary drinking water standard (5000 µg/L) or the human health consumption standards (7,400 µg/L and 26,000 µg/L for the consumption of water and organisms and organisms only, respectively). Concentrations of total zinc observed in Haile Gold Mine Creek typically were lower than those in the Little Lynches River upstream of Camp Branch Creek, except for the 95th percentile concentration at SW-01B and the 90th percentile at SW-18.

J.4.4.27 Dissolved Zinc

Dissolved zinc concentrations at seven of the stations showed concentrations at the 90th or 95th percentiles that were greater than the CMC and CCC standards for exposure of freshwater aquatic organisms (the standard for both is 36 µg/l) (Table J-59). A 95th percentile value at one of these stations (SW-05) exceeded the drinking water standard specified for total zinc (5,000 µg/l); however, this 95th percentile value is based on a single sample that may have an elevated concentration due to a reporting error in the database. The total zinc concentration report for that station and date (7/7/2009) was less than the minimum reporting limit of 20 µg/L. Many additional samples collected in the study area were less than the minimum reporting limit for zinc.

Table J-54 Dissolved Nickel Levels Observed in Surface Waters in the Study Area (µg/L) (2008–2012)

Site ID	n	pct ND (%)	Percentile						
			5	10	25	50	75	90	95
SW-01	1	100				<1			
SW-01A	16	100	<1	<1	<1	<5	<5	<5	<5
SW-01B	22	95	<1	<1	<1	<1	<5	<5	<5
SW-02	14	64	1.50	1.60	<5	<5	<5	2.71	2.80
SW-04	1	100				<1			
SW-05	16	63	1.25	1.65	1.95	<5	<5	3.00	4.50
SW-07	1	100				<5			
SW-08	16	0	5.20	5.65	6.98	9.85	14.5	***25.5***	***33.3***
SW-09	16	0	6.60	6.95	7.50	10.5	13.5	***24.5***	***35.0***
SW-11	16	6	4.08	4.95	6.53	7.25	8.53	14.00	***18.0***
SW-12	20	90	<1	<1	1.18	<5	<5	<5	2.61
SW-12A	23	78	<1	<1	<1	1.10	<5	<5	<5
SW-13	16	63	1.63	2.05	<5	<5	<5	3.60	4.85
SW-14	16	100	<5	<5	<5	<5	<5	<5	<5
SW-15	15	100	<5	<5	<5	<5	<5	<5	<5
SW-16	11	100	<5	<5	<5	<5	<5	<5	<5
SW-17	12	100	<5	<5	<5	<5	<5	<5	<5
SW-18	9	100	<5	<5	<5	<5	<5	<5	<5
SW-19	9	100	<5	<5	<5	<5	<5	<5	<5
SW-20	8	100	<5	<5	<5	<5	<5	<5	<5

Notes:

n = number of samples

pct ND = percent non-detect

Numbers in bold-faced, italicized font indicate that the value is outside of the range of water quality standards.

SW-15, SW-16, and SW-17 are the baseline sites.

If only one sample was collected, the measured value is placed in the 50th percentile column, and the other columns are blank.

Table J-55 Total Selenium Levels Observed in Surface Waters in the Study Area (µg/L) (2008–2012)

Site ID	n	pct ND (%)	Percentile						
			5	10	25	50	75	90	95
SW-01	1	100				<2.5			
SW-01A	15	100	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5
SW-01B	22	100	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5
SW-02	14	100	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5
SW-04	1	100				<2.5			
SW-05	15	100	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5
SW-07	0								
SW-08	16	100	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5
SW-09	16	100	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5
SW-11	15	93	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	1.66
SW-12	20	100	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5
SW-12A	23	100	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5
SW-13	16	100	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5
SW-14	14	100	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5
SW-15	13	100	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5
SW-16	10	100	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5
SW-17	12	100	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5
SW-18	9	100	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5
SW-19	9	100	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5
SW-20	9	100	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5

Notes:

n = number of samples

pct ND = percent non-detect

SW-15, SW-16, and SW-17 are the baseline sites.

A blank cell corresponds to a "0" number of samples, indicating that no samples were taken at the station. If only one sample was collected, the measured value is placed in the 50th percentile column, and the other columns are blank.

Table J-56 Total Silver Levels Observed in Surface Waters in the Study Area (µg/L) (2008–2012)

Site ID	n	pct ND (%)	Percentile						
			5	10	25	50	75	90	95
SW-01	1	100				<1			
SW-01A	15	100	<1	<1	<1	<1	<1	<1	<1
SW-01B	22	100	<1	<1	<1	<1	<1	<1	<1
SW-02	14	100	<1	<1	<1	<1	<1	<1	<1
SW-04	1	100				<1			
SW-05	15	100	<1	<1	<1	<1	<1	<1	<1
SW-07	0								
SW-08	16	100	<1	<1	<1	<1	<1	<1	<1
SW-09	16	100	<1	<1	<1	<1	<1	<1	<1
SW-11	15	100	<1	<1	<1	<1	<1	<1	<1
SW-12	20	100	<1	<1	<1	<1	<1	<1	<1
SW-12A	23	100	<1	<1	<1	<1	<1	<1	<1
SW-13	16	100	<1	<1	<1	<1	<1	<1	<1
SW-14	14	100	<1	<1	<1	<1	<1	<1	<1
SW-15	13	100	<1	<1	<1	<1	<1	<1	<1
SW-16	10	100	<1	<1	<1	<1	<1	<1	<1
SW-17	12	100	<1	<1	<1	<1	<1	<1	<1
SW-18	9	100	<1	<1	<1	<1	<1	<1	<1
SW-19	9	100	<1	<1	<1	<1	<1	<1	<1
SW-20	9	100	<1	<1	<1	<1	<1	<1	<1

Notes:

n = number of samples

pct ND = percent non-detect

SW-15, SW-16, and SW-17 are the baseline sites.

A blank cell corresponds to a “0” number of samples, indicating that no samples were taken at the station. If only one sample was collected, the measured value is placed in the 50th percentile column, and the other columns are blank.

Table J-57 Total Thallium Levels Observed in Surface Waters in the Study Area (µg/L) (2008–2012)

Site ID	n	pct ND (%)	Percentile						
			5	10	25	50	75	90	95
SW-01	1	100				<1			
SW-01A	15	100	<1	<1	<1	<1	<1	<1	<1
SW-01B	22	100	<1	<1	<1	<1	<1	<1	<1
SW-02	14	100	<1	<1	<1	<1	<1	<1	<1
SW-04	1	100				<1			
SW-05	15	100	<1	<1	<1	<1	<1	<1	<1
SW-07	0								
SW-08	16	100	<1	<1	<1	<1	<1	<1	<1
SW-09	16	100	<1	<1	<1	<1	<1	<1	<1
SW-11	15	100	<1	<1	<1	<1	<1	<1	<1
SW-12	20	100	<1	<1	<1	<1	<1	<1	<1
SW-12A	23	100	<1	<1	<1	<1	<1	<1	<1
SW-13	16	100	<1	<1	<1	<1	<1	<1	<1
SW-14	14	100	<1	<1	<1	<1	<1	<1	<1
SW-15	13	100	<1	<1	<1	<1	<1	<1	<1
SW-16	10	100	<1	<1	<1	<1	<1	<1	<1
SW-17	12	100	<1	<1	<1	<1	<1	<1	<1
SW-18	9	100	<1	<1	<1	<1	<1	<1	<1
SW-19	9	100	<1	<1	<1	<1	<1	<1	<1
SW-20	9	100	<1	<1	<1	<1	<1	<1	<1

Notes:

n = number of samples

pct ND = percent non-detect

SW-15, SW-16, and SW-17 are the baseline sites.

A blank cell corresponds to a "0" number of samples, indicating that no samples were taken at the station. If only one sample was collected, the measured value is placed in the 50th percentile column, and the other columns are blank.

Table J-58 Total Zinc Levels Observed in Surface Waters in the Study Area (µg/L) (2008–2012)

Site ID	n	pct ND (%)	Percentile						
			5	10	25	50	75	90	95
SW-01	1	0				*160*			
SW-01A	15	60	<20	<20	<20	<20	26.5	*37.0*	*72.1*
SW-01B	22	73	<20	<20	<20	<20	18.3	*92.9*	*613*
SW-02	14	64	<20	<20	<20	<20	22.3	*38.8*	*44.1*
SW-04	1	100				<20			
SW-05	15	80	<20	<20	<20	<20	<20	23.8	*257*
SW-07	0								
SW-08	16	38	<20	<20	<20	21.5	26.8	*37.5*	*62.5*
SW-09	16	56	<20	<20	<20	<20	26.3	*43.0*	*48.3*
SW-11	15	67	<20	<20	<20	<20	28.0	*40.0*	*53.6*
SW-12	20	80	<20	<20	<20	<20	<20	*65.2*	*86.2*
SW-12A	23	83	<20	<20	<20	<20	<20	*51.2*	*141*
SW-13	16	63	<20	<20	<20	<20	*45.8*	*95.0*	*125*
SW-14	14	57	<20	<20	<20	<20	25.3	*58.1*	*329*
SW-15	13	62	<20	<20	<20	<20	*48.0*	*427*	*558*
SW-16	10	80	<20	<20	<20	<20	<20	23.1	32.6
SW-17	12	50	<20	<20	<20	16.0	34.0	*67.0*	*96.5*
SW-18	9	56	<20	<20	<20	<20	*160.0*	*1328*	*3564*
SW-19	9	78	<20	<20	<20	<20	<20	*48.0*	*64.0*
SW-20	9	89	<20	<20	<20	<20	<20	16.8	30.4

Notes:

n = number of samples

pct ND = percent non-detect

Numbers in bold-faced, italicized font indicate that the value is outside of the range of water quality standards.

SW-15, SW-16, and SW-17 are the baseline sites.

A blank cell corresponds to a “0” number of samples, indicating that no samples were taken at the station. If only one sample was collected, the measured value is placed in the 50th percentile column, and the other columns are blank.

Table J-59 Dissolved Zinc Levels Observed in Surface Waters in the Study Area (μg/L) (2008–2012)

Site ID	n	pct ND (%)	Percentile						
			5	10	25	50	75	90	95
SW-01	1	0				***320***			
SW-01A	16	69	<20	<20	<20	<20	22.0	***41.0***	***83.0***
SW-01B	22	55	<20	<20	<20	<20	***113.3***	***342***	***455***
SW-02	14	57	<20	<20	<20	<20	33.8	***65.1***	***81.7***
SW-04	1	100	<20	<20	<20	<20	<20	<20	<20
SW-05	16	63	<20	<20	<20	<20	24.3	***166***	***55180***[a]
SW-07	1	100	<20	<20	<20	<20	<20	<20	<20
SW-08	16	31	<20	<20	<20	24.5	29.3	***39.0***	***41.8***
SW-09	16	31	<20	<20	<20	25.0	***46.0***	***80.5***	***102***
SW-11	16	44	<20	<20	<20	21.5	27.5	***37.5***	***43.0***
SW-12	20	75	<20	<20	<20	<20	12.5	***120***	***138***
SW-12A	23	74	<20	<20	<20	<20	15.5	28.8	***93.0***
SW-13	16	69	<20	<20	<20	<20	28.5	***64.5***	***147***
SW-14	16	75	<20	<20	<20	<20	13.3	***113***	***310***
SW-15	15	60	<20	<20	<20	<20	***39.5***	***128***	***327***
SW-16	11	82	<20	<20	<20	<20	<20	27.0	***73.5***
SW-17	12	67	<20	<20	<20	<20	***50.5***	***74.2***	***716.2***
SW-18	9	44	<20	<20	<20	23.0	***190.0***	***1552***	***3776***
SW-19	9	67	<20	<20	<20	<20	22.0	29.8	35.4
SW-20	8	75	<20	<20	<20	<20	14.0	***51.2***	***80.6***

Notes:

[a] This value is based on a single sample that may have an elevated concentration due to a reporting error in the database provided by Haile.

n = number of samples

pct ND = percent non-detect

Numbers in bold-faced, italicized font indicate that the value is outside of the range of water quality standards.

SW-15, SW-16, and SW-17 are the baseline sites.

If only one sample was collected, the measured value is placed in the 50th percentile column, and the other columns are blank.

J.4.5 General Chemistry

J.4.5.1 Cyanide

Cyanide historically has been used in the Project area to heap-extract gold from piles of ore. Concentrations at all of the sampling locations were below the minimum reporting limit (0.01 mg/L); and all were well below the drinking water quality standard (0.2 mg/L), the human health consumption standard (0.14 mg/L), and the CMC (0.022 mg/L). The minimum reporting limit is greater than the CCC (0.0052 mg/L) (Table J-60)

J.4.5.2 Total Suspended Solids

Changes to the natural landscape have the potential to increase the sediment loading to surface waters. The amount of suspended solids with a diameter greater than 0.45 micrometers (μm) is quantified by the total suspended solids (TSS) measurement (Table J-61). There are no numeric standards for TSS. The highest TSS concentrations at the baseline sites were observed in the Upper Camp Branch Creek stations (SW-16 and SW-17). The upper percentile concentrations in the rest of the study area were comparable to those observed at the baseline stations. However, the median concentrations in the Middle and Lower Haile Gold Mine Creek stations (SW-08, SW-09, SW-11) were higher than the baseline stations. TSS observations were less than the reporting limit (5 mg/L) at many stations.

J.4.5.3 Total Dissolved Solids

The amount of minerals and salts dissolved in water is quantified by the measurement of total dissolved solids (TDS). Median and upper percentile concentrations were higher in Lower Haile Gold Mine Creek (SW-08 and SW-09) relative to the other stations (Table J-62). All samples were below the drinking water quality standard (500 mg/L). At four stations (SW-01A, SW-01B, SW-05, SW-12), or two measurements were less than the minimum reporting limit (10 mg/L).

J.4.5.4 Sulfate

Sulfate concentrations at several locations along Haile Gold Mine Creek were above those observed at the baseline sites (SW-15, SW-16, SW-17), with the highest concentrations observed at SW-08, SW-09, and SW-11. All samples collected in the study area were below the drinking water quality standard (250 mg/L) (Table J-64). At many stations, measurements were below the minimum reporting limit (5 mg/L).

J.4.5.5 Hardness

Total hardness is the sum of carbonate hardness (presence of bicarbonate and carbonate salts) and non-carbonate hardness (e.g., calcium chloride, magnesium sulfate, and magnesium chloride salts). While there is no State standard specifically for total hardness, SCDHEC (2012) specifies that in the absence of hardness data, metal concentrations should be adjusted using a conservative estimate of 25 mg/L of $CaCO_3$. Carbonate hardness can range between 25-400 mg/L if total hardness is less than 400 mg/L and approximately 400 mg/L if total hardness is greater than 400 mg/L (SCDHEC 2012). Water hardness throughout the project area falls into all four classes: soft, moderately hard, hard, and very hard. However, at the 50th percentile, water at all sites would be considered “soft.”

Table J-60 Total Cyanide Levels Observed in Surface Waters in the Study Area (mg/L) (2008–2012)

Site ID	n	pct ND (%)	Percentile						
			5	10	25	50	75	90	95
SW-01	1	100				<0.01			
SW-01A	16	100	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
SW-01B	21	100	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
SW-02	14	100	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
SW-04	1	100				<0.01			
SW-05	16	100	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
SW-07	1	100				<0.01			
SW-08	16	100	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
SW-09	16	100	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
SW-11	16	100	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
SW-12	20	100	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
SW-12A	21	100	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
SW-13	16	100	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
SW-14	16	100	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
SW-15	14	100	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
SW-16	10	100	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
SW-17	12	100	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
SW-18	10	100	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
SW-19	10	100	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
SW-20	9	100	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01

Notes:

n = number of samples

pct ND = percent non-detect

SW-15, SW-16, and SW-17 are the baseline sites.

If only one sample was collected, the measured value is placed in the 50th percentile column, and the other columns are blank.

Table J-61 Total Suspended Solids Levels Observed in Surface Waters in the Study Area (mg/L) (2008–2012)

Site ID	n	pct ND (%)	Percentile						
			5	10	25	50	75	90	95
SW-01	1	0				5.0			
SW-01A	15	67	<5	<5	<5	<5	6.0	11.4	15.5
SW-01B	21	71	<5	<5	<5	<5	5.0	6.0	6.5
SW-02	14	43	<5	<5	<5	6.5	11.9	16.1	32.8
SW-04	1	0				10.0			
SW-05	15	73	<5	<5	<5	<5	4.5	7.4	8.0
SW-07	0								
SW-08	16	13	<5	4.0	7.4	14.5	19.3	23.0	25.3
SW-09	15	20	<5	<5	6.5	12.0	17.5	19.8	21.3
SW-11	15	0	5.0	5.4	7.0	11.0	17.0	24.2	28.8
SW-12	19	79	<5	<5	<5	<5	<5	6.0	6.3
SW-12A	21	81	<5	<5	<5	<5	<5	5.5	7.0
SW-13	15	27	<5	<5	3.8	5.0	6.0	7.5	9.6
SW-14	15	67	<5	<5	<5	<5	7.0	14.6	23.4
SW-15	13	77	<5	<5	<5	<5	<5	7.1	7.5
SW-16	11	45	<5	<5	<5	5.5	6.8	12.0	13.0
SW-17	12	25	<5	<5	4.8	8.0	17.0	27.2	33.4
SW-18	10	70	<5	<5	<5	<5	4.8	6.6	7.1
SW-19	10	70	<5	<5	<5	<5	4.8	6.7	7.3
SW-20	8	63	<5	<5	<5	<5	6.6	9.6	10.8

Notes:

n = number of samples

pct ND = percent non-detect

SW-15, SW-16, and SW-17 are the baseline sites.

A blank cell corresponds to a “0” number of samples, indicating that no samples were taken at the station. If only one sample was collected, the measured value is placed in the 50th percentile column, and the other columns are blank.

Table J-62 Total Dissolved Solids Levels Observed in Surface Waters in the Study Area (mg/L) (2008–2012)

Site ID	n	pct ND (%)	Percentile						
			5	10	25	50	75	90	95
SW-01	1	0				18.0			
SW-01A	16	6	14.8	18.0	28.5	39.0	50.3	68.5	73.8
SW-01B	22	5	18.0	18.2	22.0	37.0	47.8	52.0	67.2
SW-02	14	0	25.3	27.8	44.0	53.0	64.5	75.6	83.6
SW-04	1	0				58.0			
SW-05	16	13	<10	12.5	28.8	38.0	51.3	58.0	61.5
SW-07	1	0				18.0			
SW-08	16	0	30.5	38.5	57.8	93.0	132.5	185	225
SW-09	16	0	38.0	44.5	60.3	90.0	115.0	180	235
SW-11	16	0	25.5	33.0	55.0	83.0	97.0	160	193
SW-12	20	5	49.7	52.0	60.0	69.0	87.5	101	111
SW-12A	23	0	42.4	46.4	53.0	68.0	80.0	89.6	91.9
SW-13	16	0	54.8	56.5	63.0	72.5	84.5	100	105
SW-14	16	0	23.5	25.0	35.0	46.0	71.5	81.0	83.5
SW-15	14	0	65.3	66.0	84.5	98.0	118	127	144
SW-16	11	0	29.0	36.0	41.0	56.0	60.0	74.0	78.0
SW-17	12	0	25.1	26.6	33.5	59.0	64.5	76.8	84.3
SW-18	10	0	31.4	36.8	46.0	53.0	64.5	70.8	74.4
SW-19	10	0	14.7	17.4	24.0	43.0	50.5	72.8	76.4
SW-20	9	0	14.0	18.0	36.0	46.0	46.0	48.4	49.2

Notes:

n = number of samples

pct ND = percent non-detect

SW-15, SW-16, and SW-17 are the baseline sites.

If only one sample was collected, the measured value is placed in the 50th percentile column, and the other columns are blank.

Table J-63 Sulfate Levels Observed in Surface Waters in the Study Area (mg/L) (2008–2012)

Site ID	n	pct ND (%)	Percentile						
			5	10	25	50	75	90	95
SW-01	1	100				<5			
SW-01A	16	94	<5	<5	<5	<5	<5	<5	<5
SW-01B	22	91	<5	<5	<5	<5	<5	<5	<5
SW-02	14	7	5.4	7.0	8.7	9.9	16.0	18.7	20.1
SW-04	1	100				<5			
SW-05	16	75	<5	<5	<5	<5	<5	10.8	23.8
SW-07	1	100				<5			
SW-08	14	0	24.8	26.5	33.3	43.0	56.3	109	140
SW-09	14	0	24.0	25.5	31.3	44.0	51.3	112	148
SW-11	15	0	13.7	16.5	25.3	28.5	36.8	51.5	77.8
SW-12	20	60	<5	<5	<5	<5	<5	5.9	6.6
SW-12A	23	83	<5	<5	<5	<5	<5	5.5	6.1
SW-13	16	6	5.3	6.6	6.9	11.0	13.8	22.0	26.5
SW-14	16	63	<5	<5	<5	<5	<5	6.1	31.8
SW-15	17	59	<5	<5	<5	<5	3.8	6.6	7.3
SW-16	11	73	<5	<5	<5	<5	<5	<5	4.3
SW-17	12	83	<5	<5	<5	<5	<5	<5	<5
SW-18	10	80	<5	<5	<5	<5	<5	<5	<5
SW-19	10	70	<5	<5	<5	<5	<5	4.1	11.6
SW-20	9	89	<5	<5	<5	<5	<5	<5	<5

Notes:

n = number of samples

pct ND = percent non-detect

SW-15, SW-16, and SW-17 are the baseline sites.

If only one sample was collected, the measured value is placed in the 50th percentile column, and the other columns are blank.

Table J-65 Hardness Levels Observed in Surface Waters in the Study Area (mg/L) (2008–2012)

Site ID	N	pct ND (%)	Percentile						
			5	10	25	50	75	90	95
SW-01	1	100				5.0			
SW-01A	11	45	5.0	5.0	5.0	11.0	16.0	22.0	27.5
SW-01B	17	59	5.0	5.0	5.0	5.0	16.0	20.8	28.4
SW-02	10	10	8.2	11.3	13.0	22.5	25.8	73.2	78.6
SW-04	1	0				16.0			
SW-05	12	25	5.0	5.0	10.3	16.5	23.3	31.2	59.5
SW-07	1	0				16.0			
SW-08	10	0	24.7	27.4	47.3	52.5	61.5	76.4	82.7
SW-09	10	0	24.7	27.4	34.8	50.0	61.0	100.5	125.3
SW-11	12	0	20.7	22.0	23.5	35.5	62.3	75.0	95.3
SW-12	15	7	14.1	19.6	26.0	32.0	51.0	75.2	204.2
SW-12A	16	0	16.5	18.0	22.8	35.5	52.5	74.0	148.5
SW-13	11	0	15.0	18.0	23.5	38.0	61.5	160.0	325.0
SW-14	11	18	5.0	5.0	13.5	20.0	41.0	130.0	160.0
SW-15	9	11	11.0	17.0	24.0	48.0	120.0	232.0	256.0
SW-16	7	0	12.0	12.0	12.0	24.0	38.0	135.2	197.6
SW-17	7	29	5.0	5.0	10.5	20.0	43.5	249.0	394.5
SW-18	6	50	5.0	5.0	5.0	10.5	26.5	31.0	31.5
SW-19	6	50	5.0	5.0	5.0	10.5	26.5	35.0	37.5
SW-20	5	20	6.4	7.8	12.0	16.0	16.0	26.8	30.4

Notes:

n = number of samples
pct ND = percent non-detect

SW-15, SW-16, and SW-17 are the baseline sites.

A blank cell corresponds to a “0” number of samples, indicating that no samples were taken at the station. If only one sample was collected, the measured value is placed in the 50th percentile column, and the other columns are blank.

J.5 Methods for Assessing Impacts

J.5.1 Methodology

To quantify the impacts of mining activities and features on surface water hydrology and water quality, the following methods were used:

- GIS spatial analyses to quantify changes to the watershed using data provided by Haile
- Output from the MODFLOW groundwater model to assess changes in the baseflow regime
- Changes in watershed area or runoff coefficients to assess changes in runoff flows due to altered drainage area or land cover, topography, and permeability
- Output from the QUAL2K thermal modeling to assess changes in water temperature

- Existing reports, draft and final permits, water quality databases, and revised groundwater quality model to assess impacts to stream water quality

These methods are summarized below.

J.5.2 Watershed Alterations

Changes in the watershed are based on a comparison of spatial datasets that depict the site layout and conditions for the No Action, Applicant's Proposed Project, and Modified Project. These datasets include the areal extent of mining features as well as direct channel modifications.

Haile provided many of these spatial datasets for each year of the mine life. This chapter summarizes the greatest impacts that could occur during active mining, post mining, and long term. These data are summarized for the area draining to each waterbody by overlaying the mine plan provided by Haile Inc. with the watershed boundaries for each stream in the study area (Figure J-11).

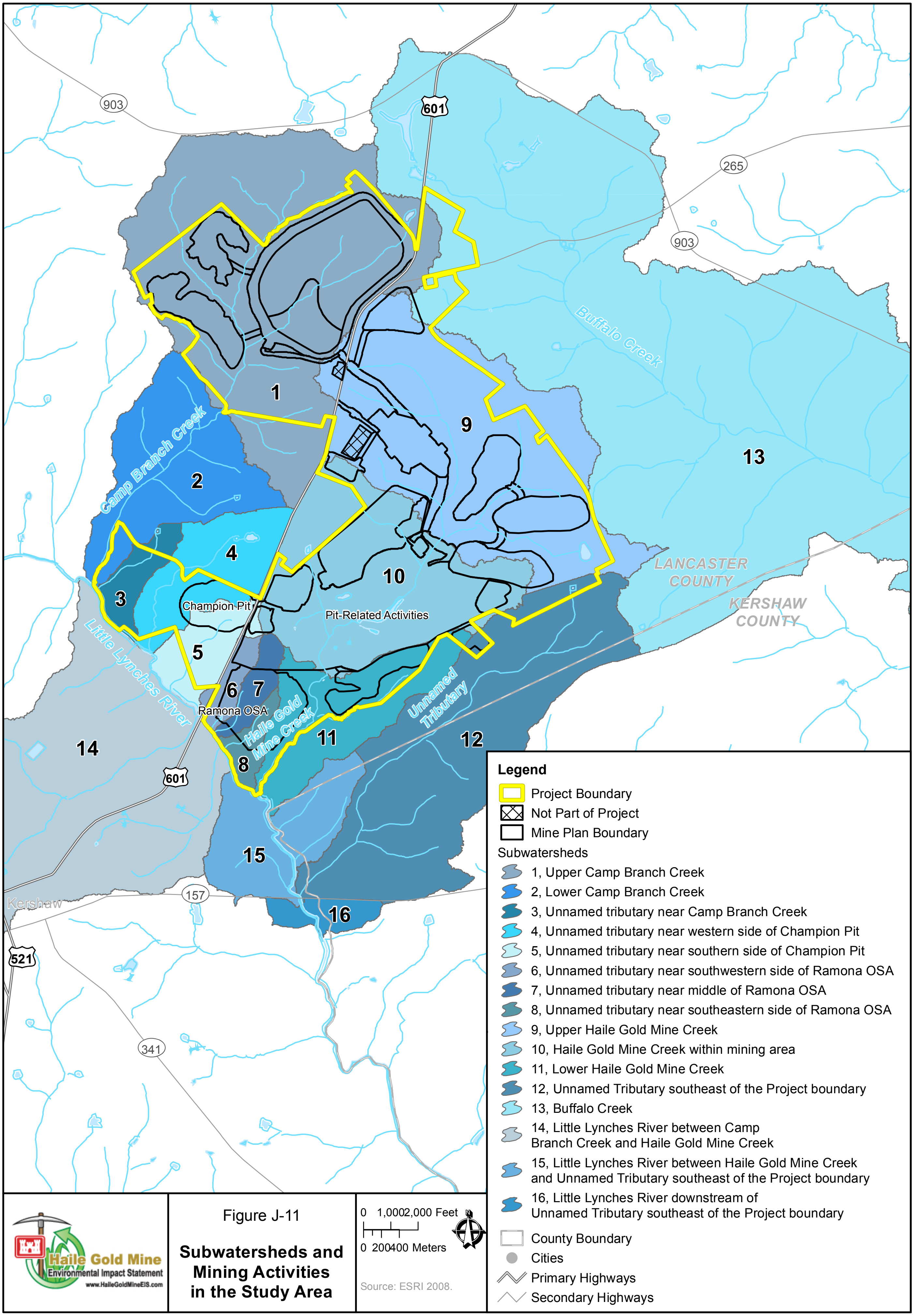

Figure J-11

Subwatersheds and Mining Activities in the Study Area

Table J-64 Proposed Water Quality Monitoring Parameters

Analyte Group	Parameter	Streams	Compliance Points	Pit Lakes
Field parameters	pH	Quarterly	Annually	Quarterly
	EC	Quarterly	Annually	Quarterly
	Temperature	Quarterly	Annually	Quarterly
	Dissolved oxygen	Quarterly	Annually	Quarterly
Nutrients	Phosphorus (ortho)	Quarterly	Annually	Quarterly
	Ammonia	Quarterly	Annually	Quarterly
	Total nitrogen	Quarterly	Annually	Quarterly
	Nitrate	Quarterly	Annually	Quarterly
Metals	Aluminum	Quarterly	Annually	NA
	Antimony	NA	Annually	NA
	Arsenic	Quarterly	Annually	NA
	Boron	NA	Annually	NA
	Chromium III, VI, total	NA	Annually	NA
	Copper	Quarterly	Annually	NA
	Iron	Quarterly	Annually	NA
	Lead	NA	Annually	NA
	Manganese	Quarterly	Annually	NA
	Mecury	Quarterly	Annually	NA
	Nickel	Quarterly	Annually	NA
	Selenium	NA	Annually	NA
	Silica	Quarterly	Annually	NA
	Thallium	NA	Annually	NA
	Zinc	Quarterly	Annually	NA
Additional chemistry	Alkalinity	Quarterly	Annually	Quarterly
	Acidity	Quarterly	Annually	Quarterly
	Sulfate	Quarterly	Annually	Quarterly
	Calcium	Quarterly	Annually	Quarterly
	Chloride	Quarterly	Annually	Quarterly
	Magnesium	Quarterly	Annually	Quarterly
	Sodium	Quarterly	Annually	Quarterly
	Potassium	Quarterly	Annually	Quarterly
	Bicarbonate/carbonate	Quarterly	Annually	Quarterly
	WAD cyanide	NA	Annually	NA
	Turbidity	Quarterly	Annually	Quarterly
	Oil and grease	NA	Annually	NA
	Fecal Coliform	NA	Annually	NA
	Total dissolved solids	Quarterly	Annually	Quarterly
	Total suspended solids	Quarterly	Annually	NA

WAD = weak acid dissociables

Source: Haile 2013.

Table J-65 Proposed Water Quality Monitoring Activities

Mining Feature	Monitoring Activity
Tailing materials and process water (cyanide management)	If the cyanide level is greater than or equal to 50 ppm WAD[a] cyanide, the flow would be directed to the cyanide destruction tanks, where cyanide levels would be reduced using a sulfur dioxide and air process. Haile will operate the gold extraction process at the Mill in accordance with the International Cyanide Management Code so that the cyanide level (measured as WAD cyanide, CNwad) in the TSF will be less than 50 ppm CNwad. In accordance with its Mining Permit, Haile anticipates that CNwad levels will be tested at the Reclaim Pond in the TSF.
Overburden testing	During the mining phase of the Project, an Overburden Material Testing Program will be used to classify individual blocks (generally, 25x25x25 feet) of overburden as Red, Yellow or Green. During mining, when benches in the pits are drilled, samples will be collected from each borehole for gold assays. A representative number of holes (not less than one in ten) will also be measured for geochemical characteristics to permit segregation of Green, Yellow and Red overburden. In general, the segregation program will be considered successful if no more than 10% of Yellow PAG is found to consist of Red PAG. Similarly, no more than 5% of Green overburden shall consist of either Red or Yellow PAG.

Notes:

[a] WAD = Weak Acid Dissociable

Source: Haile 2013.

J.5.3 Streamflow Regime

Changes in stream hydraulics are assessed primarily using flow, which is the volume of water passing a given point over a specified time (e.g., cubic feet per second or cfs). Natural streamflows are generally comprised of two components: (1) baseflow, which is the relatively steady contribution from the groundwater and (2) runoff, which occurs when precipitation falls on the land surface and flows into waterbodies. Both of these components of flow can be highly variable within a surface water system. While runoff flows can vary frequently to due to passing precipitation events, baseflows are generally more constant inputs to streams and rivers when assessed over short periods. However, at the seasonal or annual scale, baseflow contributions can be highly variable depending on the prevailing hydrologic conditions (e.g., droughts versus wet years).

Runoff flows and baseflows provide different functions relative to the stream channel and the aquatic organisms it supports. Baseflows tend to provide a more constant habitat for aquatic life, while runoff flows in sufficient quantities form the channel and move sediment. Alterations in baseflows would therefore impact habitat conditions and aquatic organisms while impacts to runoff flows could increase or decrease the amount of sediment that is eroded from channel banks and/or stored in the channel bed. Runoff flows also provide natural variability to flow conditions that, in turn, supports various stages of aquatic life. Impacts of altered baseflows and runoff flows on aquatic organisms are discussed in Section 4.7 of the draft EIS.

In a similar manner, changes in runoff and baseflows in stream channels could impact adjacent wetlands and terrestrial communities. Runoff flows that exceed the capacity of the stream naturally inundate the floodplain and adjacent wetlands (assuming the channel has not been incised to the point that connectivity with the floodplain is lost) and provide an additional source of water to support wetland conditions. Thus, decreasing runoff flows could impact floodplain wetlands by reducing the amount of water available to those systems. Baseflows also support wetland vegetation through the underlying groundwater system and are generally a more constant source of water for wetlands. Natural fluctuations in the elevation of the groundwater table alter the amount of water reaching these areas. Significant, long-term lowering of the groundwater table could cause substantial loss of wetland areas due to lack of baseflows. Impacts to wetlands and terrestrial wildlife resulting from changes in runoff and baseflows are described in Sections 4.6 and 4.8, respectively.

Changes in the flow regime could also impact water levels in the pit lakes and ponds within the study area. Runoff flows that contribute directly to these impoundments fill and maintain water levels. Unlined impoundments can also receive flow from the groundwater system below. As water levels in the impoundments reach a certain level, flows pass through the outlet structure and discharge to stream channels that are downstream. The water levels in pit lakes also affect the chemistry and water quality in the pit lake and the downstream reaches.

J.5.3.1 No Action Scenario

To describe the current flow conditions for streams in the study area, ERC developed estimates of daily baseflows, runoff flows, and total flows using a baseflow separation analysis (Appendix J) based on data collected at a nearby USGS flow monitoring station on Hanging Rock Creek (USGS Gage 02131472). Flow components from this gage were prorated by drainage area to estimate the runoff and total flow components for the streams in the study area for the No Action scenario (see ERC 2013b). The baseflow component of flow for streams in the study area is based on the Hanging Rock Creek baseflow separation analysis and a scaling factor derived from the steady state MODFLOW model that represents pre-mining conditions. Use of the MODFLOW model to predict baseflows for both the No Action and Proposed Project provides a more consistent methodology for predicting impacts.

J.5.3.2 Proposed and Modified Project Scenarios

Impacts of mining operations on flow could be direct (e.g., removal of drainage area from the Upper Camp Branch Creek drainage basin due to construction of the TSF) or indirect (e.g., reductions in flow in Lower Camp Branch Creek resulting from the direct impacts occurring in Upper Camp Branch Creek drainage basin). Mining activities could impact both the runoff and baseflow components of flow. For this impact assessment, the direct and indirect impacts for a given waterbody are analyzed simultaneously using net flows in each stream reach.

For the impacts analysis, the changes in daily flows were calculated by applying scaling factors to the runoff and baseflow components. Runoff scaling factors were calculated based on the change in contributing drainage area for a waterbody (e.g., subtracting runoff flows from the area of the TSF in the Upper Camp Branch Creek drainage basin) or based on the change in runoff coefficient (ERC 2013b) resulting from disturbances such as roads and OSAs. Baseflow scaling factors were derived from the transient MODFLOW groundwater model that predicts average annual baseflows to streams in the study area during and after mining. Derivation of these scaling factors is described by ERC (2013b).

J.5.4 Water Temperature

Impacts of mining operations on water temperature may be direct (e.g., discharge to a stream reach) or indirect (e.g., reductions in flow caused by groundwater depressurization cause streamflows to become stagnant with greater exposure to solar radiation). For this impact assessment, the direct and indirect impacts for a given waterbody are analyzed simultaneously using net flows and water temperatures resulting from mining operations affecting each stream reach. Relative changes are then compared to thermal metrics based on SCDHEC (2012) criteria which states that discharges should not raise the temperature of the receiving stream by more than 5°F above natural temperatures or result in a stream temperature greater than 90°F. The SCDHEC temperature criteria for lakes are the same as for free flowing waters. The SCDHEC criteria focus on increases to water temperatures. For this project, there would also be decreases to stream temperatures during the summer months due to the discharge of pit depressurization water. The same threshold change of 5°F is used to assess the relative change in decreases in water temperature.

To assess the impacts of mining operations on stream temperatures, Cardno ENTRIX developed a QUAL2K thermal model to simulate water temperatures before, during, and after mining. QUAL2K uses model inputs to describe ambient air temperatures, cloud cover, solar radiation, and stream shading along with flow, velocity and depth information to simulate stream temperatures.

J.5.5 Water Quality

The methodology for assessing impacts to water quality as a result of mining operations is a qualitative assessment integrating permit requirements, water quality monitoring data, water quality modeling conducted by Haile, and an understanding of water chemistry associated with changes in flow, thermal regime, and geochemical disturbances. These sources of information include:

- Operational permits issued by the USACE and SCDHEC;
- Haile Gold Mine Water Quality Database (Haile 2012a);
- Ecological Risk Assessment for the Proposed Future Ledbetter Pit Lake (ARCADIS 2012);
- Draft Haile Gold Mine Revised Post-Closure Water Quality Impact Evaluation (AMEC 2013);
- Pit Lake Water Quality Modeling Report (Schafer 2013);
- Haile Gold Mine - Pit Dewatering and Depressurization Summary (Schlumberger et al. 2010);
- Past Activities at Haile Gold Mine Site with Information about Reclamation and Water Quality (Haile 2012d);
- Surface Water Quantity and Quality Affects (ERC 2011);
- Surface Water Existing Conditions Report (ERC 2012a);
- Predicted Indirect Impacts to Streamflows, Wetlands, and Upland Vegetation from Depressurization and Other Site Activities (ERC 2012b); and
- Revised Post-Closure Water Quality Impact Evaluation (Schafer 2014).

J.6 Surface Water Impacts by Mining Features and Activities

J.6.1 Watershed Alteration

Watershed alterations are primarily caused by land disturbance activities which would include road construction, pit development, sedimentation ponds, channel modifications, and formation of overburden and tailings storage facilities. The proposed Project includes construction of mining pits up to 900 feet deep and development of Ledbetter Pit Lake, which is intended as a permanent feature and would serve as a storage and conveyance along Haile Gold Mine Creek.

Watershed alterations would directly affect hydrology by altering land slope, soil permeability, vegetative cover, and the routing and storage of water in the Project area. These changes would also impact pollutant loading by increasing surface runoff and erosive forces on both the landscape and stream channels, altering pollutant fate and transport in lakes and stream channels, and concentrating waste material into stockpiles or sedimentation basin discharges.

J.6.1.1 Proposed Roads

Haile would construct access and haul roads throughout the Project area to allow access and transport of material to and from the various mine activities. Road construction will include clearing, grubbing, grading, and surfacing (typically with gravel) as well as formation of berms and ditches. Some roads would be parallel to a pipeline corridor. The maximum haul road design gradient is 10 percent (Appendix A).

Roads that are needed for post-mining activities or land uses would remain as roads; unnecessary roads would be closed, graded, and stabilized with vegetation during the reclamation period.

Road construction is accounted for in the watershed impact analysis in two ways. First, the number of road crossings for each stream segment is identified (see Section 4.7 of the draft EIS). Second, the area of disturbance due to road construction is accounted for in the disturbed area for each mining operation (e.g., OSAs, TSF).

J.6.1.2 Runoff Diversion Facilities

Diversion facilities would include earthen berms, dikes, and conveyances designed to divert runoff that originates on undisturbed areas away from disturbed areas and ultimately to natural drainages such as streams. Diversions would also be used to divert stormwater runoff from non-PAG (potentially acid generating) materials away from stormwater runoff originating in PAG areas. Non-contact stormwater runoff would be diverted by either earthen or piped conveyances to down-gradient sedimentation ponds (Appendix A). Design specifications for these facilities are described in the SCDHEC Storm Water Management BMP Handbook (SCDHEC 2005). Runoff that originates from PAG areas is captured in facility specific ponds and pumped to the ore processing facility: runoff from PAG facilities would not be managed using diversion channels. Runoff diversion features are not proposed at the borrow areas or growth media storage areas.

During reclamation, runoff diversion facilities would be graded to promote sheet flow[1] and stabilized with vegetation.

J.6.1.3 Sedimentation Ponds

Sedimentation ponds would capture and treat non-contact water that runs off of non-PAG containing areas at the growth media storage areas, TSF, OSAs, Johnny’s PAG, and the ore processing facility (Appendix A). The sedimentation ponds would within the Project Boundary would be designed according to specifications described in the SCDHEC Storm Water Management BMP Handbook (SCDHEC 2005) to reduce influent TSS by 80 percent. Design specifications indicate that drainage areas to each pond should be within 5 acres to 150 acres. These features are not proposed at the borrow areas.

During reclamation, sedimentation ponds would be filled, graded, and stabilized with vegetation. This would not occur until the area draining to the sedimentation pond is fully reclaimed and stabilized.

1 Sheet flow indicates that water spreads evenly over the land surface and does not form channels or gullies.

J.6.1.4 Pit Development

Pits would be excavated below grade to recover gold and silver reserves. Haile would mine eight pits over the course of 14 years. Early in the operations, the existing Ledbetter Reservoir would be drained to allow access to the pit floor. Formation of new pits and deepening of existing pits would reduce the contributing drainage area (precipitation that falls on the pit is also pumped out and discharged downstream) and directly impact stream segments that are within the pit boundary. The total planned footprint for the eight pits is approximately 766 acres (including the infrastructure necessary to support mining of the pits, such as haul roads, utility lines, pumping wells, temporary laydown areas, and stormwater management infrastructure). The excavated pit depths would range from 110 feet to 840 feet below the original grade, which would be a maximum depth of 380 feet below mean sea level (Appendix A). To extract the reserves from the pits, the groundwater that would otherwise fill the pits would be drawdown with a series of perimeter wells and discharged downstream of active mining along Lower Haile Gold Mine Creek. Runoff that falls in the pits would be pumped out and treated as contact water.

During reclamation, four pits (Mill Zone, Haile, Red Hill, and Chase Pits) would be completely backfilled with overburden, and a fifth (Snake Pit) would be partially backfilled with overburden. Overburden classified as Yellow and Green Class (see Section 3.2 of the draft EIS for descriptions of Red, Yellow, and Green overburden) would be placed as pit backfill. The Yellow Class backfill would be placed in discrete levels not more than 50 feet thick, and the final lift would be capped with a 5-foot layer of saprolite to limit oxygen transport into the backfilled pit. Green Class overburden could be placed in the pits along with or in lieu of Yellow Class overburden but would be the only class of overburden placed above the long-term inundation elevation. The placement would complete backfilling to grade and be designed to allow stormwater flows to run off the backfilled area. Once backfilled to the surface, the pit area would be graded, contoured with growth media, and seeded. Three of the pits (Ledbetter, Small and Champion) would not be backfilled during mining or reclamation and would be reclaimed as pit lakes. The portion of Snake Pit that is not backfilled would also be reclaimed as a lake which would become part of Ledbetter Pit Lake. During reclamation, a security fence and/or safety berm would be established around the remaining pit lake highwalls (Appendix A).

J.6.1.5 Channel Modifications and Diversions

Many of the stream channels within the Project Boundary would be modified or diverted. Sections of both Haile Gold Mine Creek and North Fork Haile Gold Mine Creek would be diverted around mining operations in 24-inch pipelines (two per diversion). A detention structure would be constructed on Haile Gold Mine Creek upstream of mine activity to capture runoff and streamflows from Upper Haile Gold Mine Creek (ERC 2013b). This diversion would discharge to Lower Haile Gold Mine Creek downstream of the mining activities.

Concurrent reclamation could occur in Year 7 for the section of North Fork Haile Gold Mine Creek that was diverted around the 601 OSA once the 601 OSA is regraded and recontoured. After the backfilling of Mill Zone Pit, the remaining sections of the North Fork Haile Gold Mine Creek would be re-established. However, flows would likely not be restored in this section until Year 11. Following backfill of Red Hill and Haile Pit, the section of Haile Gold Mine Creek diverted around these pits would be reconstructed in the backfilled areas. Flows would be restored in this section by the end of Year 12. Once full, the entire flow of Haile Gold Mine Creek would be redirected to run through Ledbetter Pit Lake. The low head dam would be removed, the area reclaimed, and that portion of Haile Gold Mine Creek restored shortly after the Ledbetter Pit Lake is completely filled (Appendix A).

J.6.1.6 Overburden Storage Areas

Overburden storage areas (OSAs) are piles comprised of the Green overburden (low PAG content) removed from the pits to expose the gold reserves. The six planned OSAs would alter the watershed by forming above grade piles of material (601, Ramona, Hilltop, Hayworth, Robert, and James OSAs). Overburden material would be stored or used on site. During mine operations, the various OSAs would be used to store approximately162 million tons, or 67 percent, of the overburden material generated from digging the pits. Approximately 67 million tons, or 28 percent of the overburden, would be used to backfill pits. Another 12 million tons of overburden, or 5 percent, would be used for construction of the TSF (Appendix A).

During reclamation, the six OSAs would be reclaimed concurrently during mining as each reaches its designed capacity. Final grading of five of the OSAs would consist of alternating benches and slopes for an overall slope of 3:1 (horizontal: vertical). Surface water controls would be constructed to limit erosion. All of the material stored at the 601 OSA would be used to backfill pits during reclamation. This OSA would be contoured at grade, and North Fork Haile Gold Mine Creek would be reconstructed in this area. All reclaimed OSAs would be vegetated according to the vegetation plan contained in the Reclamation Plan approved by SCDHEC, Division of Mining (Appendix A).

J.6.1.7 Growth Media Storage Areas

Prior to the start of mining, the surface soils would be removed from the pit areas, Johnny's PAG, and the TSF and stored in designated growth media storage areas for later use in reclamation and stabilization of storage sites (OSAs, Johnny's PAG, and TSF). The growth media would be stored in the four growth media storage areas (Appendix A) which would be above grade piles of material during mining with 3:1 side slopes.

During reclamation, all material in the Growth Media Storage Areas would be used to reclaim other mining features. Reclamation of these areas would then include grading and stabilizing with vegetation.

J.6.1.8 Johnny's PAG

Johnny's PAG is a lined facility designed to contain Yellow and Red overburden that is potentially acid generating. Johnny's PAG would also include a low-grade ore stockpile and two contact water collection ponds (465 Pond and 469 Pond). The ultimate footprint of Johnny's PAG would be approximately 159 acres. The overburden material placed within the limits of Johnny's PAG would be constructed with an overall slope of 3:1 and built to a maximum toe-to-crest height of approximately 250 feet (Appendix A).

For purposes of reclamation, to help minimize oxygen and limit rainfall infiltration into the overburden during the construction of Johnny's PAG, a minimum 20-foot thick layer of saprolite would be placed on the entire outer slope. The final lift on the top of Johnny's PAG would be covered with a 5-foot thick layer of saprolite. After saprolite is placed along the slopes and top of Johnny's PAG, the entire area would be covered by a 60-mil high-density polyethylene (HDPE) liner and two feet of growth media. The final slopes would be constructed with alternating benches and slopes with an overall slope of 3:1 to provide surface water controls to limit erosion and manage stormwater. The area would then be seeded for stabilization in accordance with the Reclamation Plan approved by SCDHEC, Division of Mining (Appendix A). The 465 and 469 collection ponds would be converted to passive treatment cells once seepage flows declined sufficiently. These cells would discharge to Haile Gold Mine Creek upstream of Ledbetter Pit Lake (Schafer, AMEC, ERC 2013a).

J.6.1.9 The Tailings Storage Facility

The Tailings Storage Facility (TSF) is a lined feature that would be constructed in the Upper Camp Branch Creek drainage basin. The facility would cover 524 acres that include the TSF and Reclaim Pond, the TSF Underdrain Collection System and Underdrain Collection Pond, reclaim pipes that feed the ore processing facility, a perimeter service road, diversion channels, sedimentation ponds, and the TSF growth media storage area. Changes would include grading; excavation; construction of roads, sedimentation basins, and diversion channels; placement of an HDPE liner and the Underdrain Collection System; and placement of tailings during operation of the ore processing facility. At the end of mining, the TSF would contain approximately 40 million tons of tailings and have an above ground elevation of 150 feet above the lowest natural grade and 50 feet above the highest natural grade (Appendix A). Approximately 6,230 feet of stream in the Upper Camp Branch Creek drainage basin would be directly impacted (e.g., covered) by the TSF during mining, reclamation, and the long-term periods.

In the final months of ore processing, the tailing would be deposited in the TSF in a manner that promotes positive draining of the tailing reclaim pond. As the surface of the tailing is stabilized and shaped for stormwater management, a 60-mil HDPE geosynthetic liner would be placed over the tailing in stages. A minimum of two feet of growth media would be placed over the geosynthetic liner, and the entire area would be vegetated using established procedures. Stabilization of the entire TSF and complete placement of the cover would take approximately 5 to 10 years after final tailing deposition to allow for stabilization of the tailing material (Appendix A). During this time, the reclaim pond would be filled with tailing material and eventually be encapsulated within the reclaimed TSF. The Underdrain Collection System would continue to collect and route seepage from the TSF to the Contact Water Treatment Plant, which would be reconfigured through the permit process to treat seepage from the TSF. Over time (estimated by Haile to be approximately 20 years) seepage rates would decrease to the point that the seepage water treatment plant would be decommissioned and the Underdrain Collection Pond would be converted to a passive treatment system.

J.6.1.10 Holly and Hock TSF Borrow Areas

The Holly and Hock TSF borrow areas cover an area of 187 acres in the Upper Camp Branch Creek drainage basin. Approximately 4 million cubic yards of material from these borrow areas would be used to construct the embankments for the TSF. The surface grade of these areas would decrease by up to 50 feet depending on the location and existing grade (Appendix A).

During reclamation, borrow areas would be graded and stabilized with vegetation.

J.6.1.11 Ore Processing Facility and Process Ponds

The ore processing facility, also referred to as the Mill Site, is a 103-acre area that would include the facilities for ore processing; chemical storage, mixing, and distribution; water storage; chemical containment systems including the process event pond; the 19 Pond (stores contact water from pit sumps and Johnny’s PAG); fuel storage; maintenance shops; truck wash; warehouse; administrative offices; and parking. An additional 86 acres would include the Utility Pond, the haul road to the TSF, the Mill Site service roads; the site access road; and highway overpass. The Utility Pond would be comprised of two, 25 million gallon cells that would be used to store excess depressurization water in the event that depressurization rates during some periods of operation where not sufficient to meet operational requirements at the mill. Watershed changes to construct the ore processing facility include grading activities and construction of the ore processing facility, roads, sedimentation ponds, process event pond, 19 Pond, and the Utility Pond (Appendix A).

During reclamation, the ore processing facility would be demolished and the underlying area graded and stabilized with vegetation.

J.6.1.12 Contact Water Treatment Plant

The Contact Water Treatment Plant would be situated within the ore processing facility. This facility would be located between the administration building and the tailing thickener area. Effluent from this facility would be discharged to North Fork Haile Gold Mine Creek, which would be diverted around active mining pits to Lower Haile Gold Mine Creek.

During reclamation, the Contact Water Treatment Plant would be recommissioned and permitted to treat seepage water from the reclaimed TSF. This facility would discharge to Haile Gold Mine Creek upstream of Ledbetter Pit Lake (Schafer, AMEC, ERC 2013a). Once seepage flows decreased to the point that SCDHEC deemed it appropriate to treat those flows in a passive treatment system, all facilities associated with the contact/seepage water treatment plant would be demolished and the underlying area graded and stabilized with vegetation.

J.6.2 Changes to Streamflow Regime

Changes to the flow regime within and outside of the Project area may be due to watershed changes, water storage in pit lakes, channel damming and rerouting, pit depressurization, discharge of pit depressurization water, and effluent discharge from the Contact Water Treatment Plant. Depending on the stream segment, flows may either increase or decrease depending on the net effects of these flow regime changes. Impacts due to pit lakes may be long-term as these features are permanent changes to the land scape.

Hydrologic impacts include direct discharges to streams as well as alteration of drainage areas and land cover and decreases in baseflows2 in nearby waterbodies due to pit depressurization and lowering of the groundwater table. These impacts would become more significant as mining progresses and the changes become more significant (e.g., pits become deeper, OSAs become larger). In addition to streams, lowered groundwater tables may affect drinking water wells and surface water impoundments in the local area, aquatic resources, and wetland resources (see Sections 4.5, 4.7, and 4.6, respectively, in the draft EIS).

J.6.2.1 Proposed Roads

- Road construction could alter the runoff of precipitation from the land surface by changing the land cover, land slope, soil permeability, and drainage pathways. Runoff from roads would be approximately twice that of the undisturbed area (ERC 2013b).
- Following reclamation, many of the roads would be decommissioned, graded, and stabilized with vegetation. These areas would no longer impact flows in the receiving streams. The roads that would remain to support long-term land use could continue to cause minor impacts to surface water flows.

J.6.2.2 Runoff Diversion Facilities

Runoff diversions serve to route water away from disturbed areas or PAG material or to sedimentation ponds. This mine feature would not cause significant impacts to flow relative to other features such as stream discharges or reduction in drainage area.

[2] *Baseflow* refers to the relatively steady contribution from the groundwater system to streams.

Following reclamation, runoff diversion facilities would be decommissioned, graded, and stabilized with vegetation. These areas would no longer impact flows in the receiving streams.

J.6.2.3 Sedimentation Ponds

Sedimentation ponds would be sized to contain the 10-year, 24-hour storm event as required by SCDHEC, Bureau of Water's standards and Haile's Industrial General Permit. These ponds would mitigate peak flows from the Proposed Project to receiving stream channels by storing runoff and releasing it slowly to mimic flows that would occur under the No Action Alternative. Sedimentation ponds may also decrease the total volume of flow by allowing for evaporation and infiltration; however, these changes to total flow should be minimal as the ponds are designed to drawdown over a 36- to 72-hour period.

Following reclamation, sedimentation ponds would be filled, graded, and stabilized with vegetation. These areas would no longer impact flows in the receiving streams.

J.6.2.4 Pit Development

Pit development would require draining Ledbetter Reservoir and discharging the water to Lower Haile Gold Mine Creek. During operations, each of the actively mined pits would be dewatered and depressurized. These depressurization activities would lower the groundwater table in the study area and would cause reductions in baseflows for the streams in the study area (discharge of this water is discussed under discharge of groundwater depressurization water). Runoff flows in streams downstream of pits would also be affected because precipitation that falls in the pits would be pumped to the Contact Water Treatment Plant. Downstream of the groundwater dewatering discharge point, streamflows in Haile Gold Mine Creek would increase relative to ambient conditions except during periods when all of the depressurization water is needed for mining operations.

During reclamation, backfilled pits would be graded and vegetated. These areas would contribute runoff flows to the downstream segments. The three pit lakes would store runoff water and likely reduce streamflows in the receiving waterbodies. Haile estimates that it would take approximately 30 years for the three pit lakes to fill. While Haile would maintain minimum flows in Haile Gold Mine Creek while Ledbetter Pit Lake is filling, post reclamation the only releases to Haile Gold Mine Creek would be through the outlet of this pit lake. Because Champion and Small Pits would be the last developed, they would not be backfilled. Groundwater, rainfall, and runoff would gradually fill these lakes over a 30 year period until equilibrium water level is reached (i.e., inflows equal outflows). There would be no stream inflow or outflow from these pit lakes (Appendix A), so these areas would not contribute to the watershed area of the receiving streams. The only discharge from these lakes would be through the groundwater which would flow toward the Little Lynches River. Water in Ledbetter Reservoir would interact similarly with the groundwater system with flows toward Haile Gold Mine Creek and Little Lynches River (Schafer, AMEC, ERC 2013a). Annual average discharge from Ledbetter Reservoir to Haile Gold Mine Creek would be 3.3 cfs based on the groundwater model.

J.6.2.5 Channel Modifications and Diversions

The channel diversions of North Fork and Haile Gold Mine Creeks would eliminate flow in parts of the stream. The diversions would likely not impact the volume of flow in the receiving channels, but discharge velocities and erosive forces could be high relative to ambient conditions. Energy dissipation structures would be used to reduce the erosive forces prior to discharge to the stream channel (Appendix A).

Channel reconstruction would occur during reclamation with a design capacity of a 100-year, 24-hour storm event (Appendix A). The filling of Ledbetter Reservoir during reclamation would require diversion of flows from Haile Gold Mine Creek. Haile reports that minimum flows in Haile Gold Mine Creek would be maintained at the following rates: 0.97 cfs for the months of January through April, 0.73 cfs for the months of May and December and 0.48 cfs for the months of June through November (Haile 2012b).

J.6.2.6 Overburden Storage Areas

Construction of the OSAs during mining would alter the slopes and land cover of the six affected areas. During small rain events, the porous nature of the overburden material which would be comprised of sand, clay, and heavily weathered bedrock (Appendix A) could intercept and retain much of the precipitation, and decrease the runoff flows to receiving stream channels. During very wet periods, precipitation could exceed the storage capacity of the material and result in runoff. Therefore, runoff flows could decrease relative to the No Action alternative, but this reduction would depend on the amount of precipitation that occurs and the antecedent moisture conditions of the OSA material.

Stormwater channels would be constructed around the footprint of each OSA to collect stormwater runoff and associated sediment. This stormwater would then be routed to a sedimentation pond prior to discharge to the environment. Together, these features would not significantly alter the total volume of runoff, but would reduce the peak discharge rates due to storage and managed release from the ponds.

Following reclamation, the graded, vegetated OSAs would contribute a similar volume of runoff flow relative to the No Action scenario. Seepage through the OSAs would discharge to the groundwater system (Schafer, AMEC, ERC 2013a). The reclaimed 601 OSA would include the reconstructed North Fork Haile Gold Mine Creek (Appendix A).

J.6.2.7 Growth Media Storage Areas

Construction of the growth media storage areas during mining would alter the slopes and land cover of the four affected areas. This could cause an increase in runoff from these areas relative to the No Action scenario. Channels would be constructed around the footprint of each growth media storage area to collect stormwater runoff and associated sediment. This stormwater would then be routed to a sedimentation pond prior to discharge to the environment. Together, these features would not significantly alter the total volume of runoff, but would alter the shape of the hydrograph relative to the No Action Alternative due to storage and managed release from the ponds.

Following reclamation, the graded, vegetated growth media storage areas would contribute a similar volume of runoff flow as the No Action alternative.

J.6.2.8 Johnny’s PAG

Contact water including seepage and runoff from Johnny’s PAG would be collected and stored in the 465 Collection Pond and 469 Collection Pond prior to conveyance to the ore processing facility or the Contact Water Treatment Plant. “Seepage” is water that may collect within the stored material and seep to the collection system above the HDPE liner. “Runoff” is rain water that may land on the stored material and run off the surface. These ponds would be sized to contain the 100-year, 24-hour precipitation event (Appendix A). Therefore Johnny’s PAG, which is a lined facility, would reduce streamflows in Lower Haile Gold Mine Creek and the Little Lynches River downstream of Haile Gold Mine Creek because precipitation that falls on the associated 159 acres would be collected and conveyed elsewhere.

Final reclamation of Johnny's PAG includes a geosynthetic cover and a minimum of two feet of growth media. The growth media would be stabilized with vegetation, and the reclaimed area of Johnny's PAG would again contribute runoff flows to receiving streams. Seepage resulting from years of the PAG being exposed to precipitation and the precipitation infiltrating the PAG material, would continue to drain and collect on the HDPE liner under the PAG. This PAG seepage would continue to be collected in either the 465 Collection Pond or 469 Collection Pond, sent to the 19 Pond, and treated in the same manner as during the operating period. Since precipitation would be prevented from infiltrating the overburden once the cap (both saprolite layer and HDPE liner) is in place, the seepage from the overburden would decrease significantly in a short time (Appendix A). Once the seepage decreased sufficiently as decided by SCDHEC, the 465 Collection Pond and 469 Collection Pond would be converted to passive treatment cells that would discharge to Haile Gold Mine Creek upstream of Ledbetter Pit Lake.

Groundwater would be routed under Johnny's PAG to avoid contact via collection pipes that would be installed below the low-permeability soil liner. Diverted groundwater would be routed to a tributary of Haile Gold Mine Creek (Appendix A) and streamflows in this stream and those downstream would increase as a result of this discharge.

J.6.2.9 Tailings Storage Facility

Construction of the TSF would result in a reduction in contributing drainage area of 406 acres (ERC 2013c) which would decrease runoff and total flows in Upper Camp Branch Creek and Lower Camp Branch Creek. Seepage and runoff from the lined portion of the TSF would be routed to the ore processing facility in a closed loop system and would not be discharged to the environment during active mining. The design flow rate for the underdrain flows from the TSF to the ore processing facility is 350 gallons per minute (gpm) (ERC 2013b). An additional 93 acres around the TSF would contribute increased runoff flows relative to the No Action alternative due to changes in topography, land cover, and soil permeability. These increases in runoff flow partially offset the reduction in runoff flow resulting from the lined area of the TSF.

Stabilization of the entire TSF and complete placement of cover would take approximately 5 to 10 years after final tailing deposition. During this time, stormwater runoff from the partially covered TSF basin will be managed within the basin of the TSF and treated along with the drain down water from the TSF Underdrain Collection Pond. Stormwater will not be allowed outside the TSF basin until the stormwater is completely isolated from the tailing surface. Following stabilization, the graded, vegetated TSF would contribute a similar volume of runoff flow to the undisturbed condition. Seepage flows from the TSF would be treated in the reconfigured Contact Water Treatment Plant until flows were low enough to be treated in passive treatment systems (expected to occur within 20 years of stabilization). These systems would be maintained to provide long-term treatment of seepage from the TSF.

J.6.2.10 Holly and Hock TSF Borrow Areas

Topographic and land cover changes at the Holly and Hock TSF borrow areas could impact flows in Upper and Lower Camp Branch Creeks by contributing more runoff relative to the No Action alternative. However, compared to the impacts that would be caused by the TSF and the lowering of the groundwater table to depressurize the pits, these impacts would likely be insignificant.

Following reclamation, the graded, vegetated borrow areas would contribute a similar volume of runoff flow to the undisturbed condition.

J.6.2.11 Discharge of Groundwater Depressurization Water

During mining, the groundwater depressurization water would be stored in above ground storage tanks, piped around mining activities, and then discharged to Lower Haile Gold Mine Creek. Stream segments downstream of the discharge point would have greater volumes of flow relative to the No Action alternative. The discharge from the groundwater depressurization would pass through an energy dissipation structure prior to release to Creek. This discharge would increase flows in the receiving stream with a greater impact during low flow conditions. Discharge flow rates for this activity could be as high as 5 cfs (Haile 2012c).

After the active mining period, pit depressurization water would no longer be discharged to Lower Haile Gold Mine Creek.

J.6.2.12 Ore Processing Facility and Process Ponds

The water needed to support ore processing would come from several sources: reclaimed water from the TSF, depressurized groundwater, contact water from the pit sumps and Johnny's PAG (rare circumstances), moisture retained within the ore, and municipal water as needed (Appendix A). Runoff from this facility would be managed separately for contact water (stored in either the 19 Pond) or non-contact water (routed through a sedimentation pond prior to release to the environment). During dry weather conditions, depressurization water would be utilized at a higher rate than during wet conditions when the TSF would likely produce more water. Thus, the ore processing facility would impact how much groundwater is discharged to Haile Gold Mine Creek. Direct releases from the ore processing facility or the associated process ponds would not occur.

Following reclamation, the ore processing facility would be decommissioned, graded, and vegetated. This area would no long impact flows in the receiving streams.

J.6.2.13 Contact Water Treatment Plant

The Contact Water Treatment Plant would be designed to treat 1,200 gpm (2.7 cfs) of contact water. Based on the site wide water balance, discharge rates could be as high as 6 cfs (Haile 2012c). Actual discharge rates would vary based on weather patterns and water requirements to support mine operations including pit development (depressurization), ore processing, dust suppression, etc. The discharge from the Contact Water Treatment Plant would pass through an energy dissipation structure prior to release to Haile Gold Mine Creek. This discharge would increase flows in the receiving stream with a greater impact occurring during low flow conditions.

After mining has ceased and seepage water from Johnny's PAG is being treated passively, the Contact Water Treatment Plant would be reconfigured to treat seepage from the TSF. Eventually the TSF would drain down to the point that seepage could be treated passively at the TSF as well. At the end of reclamation when the TSF is drained down sufficiently, the Contact Water Treatment Plant would be decommissioned, graded, and vegetated. This area would no long impact flows in the receiving streams.

J.6.3 Changes to Stream Temperature

A minimal amount of temperature data in streams within the study area has been collected. Based on this limited dataset, ambient stream temperatures range from less than 41 °F in the winter months up to 86 °F in the summer months (Appendix J).

Changes in stream water temperatures due to mining activities could result from direct or indirect impacts. Direct impacts would include discharge of Contact Water Treatment Plant effluent or groundwater depressurization water, creation of pit lakes, stream diversions, and runoff flows. Impacts due to pit lakes may be long-term as these features are permanent changes to the land scape. Discharge of treated water and groundwater depressurization water could raise or lower the stream temperatures depending on the ambient water temperatures relative to the effluent temperatures. Indirect impacts could result from altered streamflows caused by (1) altered flows in upstream drainages; or (2) lowering of the groundwater table during pit development. Changes in flow could alter the residence time of the water in the streams (the amount of time the water is moving through the waterbody), the exposure to solar inputs, the relative importance of sediment temperatures and ambient air temperatures on the water temperatures, the relative contributions from baseflows that tend to have a more constant water temperature, and the diurnal variability that would otherwise occur in the natural system. Mining features with potential impact to water temperature are described in the following sections.

J.6.3.1 Proposed Roads

The disturbed area associated with road construction could result in warmer runoff temperatures because non-vegetated surfaces often have warmer temperatures than those covered with grass, brush, or trees, particularly during warmer months. This impact to water temperature would likely be minor relative to other Project activities and features because road construction comprises a relatively small area.

Water temperatures from the runoff of the reclaimed, vegetated road area would be similar to the undisturbed conditions. Thus, there would be little impact to receiving stream water temperatures from this site following reclamation and into the long term. The roads that would remain to support reclamation and long-term land use would have a similar impact to water temperatures as the active mining period, which would be minimal.

J.6.3.2 Runoff Diversion Facilities

Runoff diversions serve to route water away from disturbed areas or PAG material. This mine feature would not cause significant impacts to water temperature relative to other features such as direct discharges to streams or reduction in drainage area.

Following reclamation, runoff diversion facilities would be decommissioned, graded, and vegetated. These areas would no longer impact water temperatures.

J.6.3.3 Sedimentation Ponds

Sedimentation ponds would be constructed as open water bodies without tall vegetation around the perimeter. Because these ponds are open to the sun with potentially little shading, the water that is discharged could be warmer than the stream water which is shaded by canopy in many places and generally well mixed relative to the ponds.

Following reclamation, sedimentation ponds would be filled, graded, and vegetated. These areas would no longer impact water temperatures in the receiving streams.

J.6.3.4 Pit Development

During active mining, drawdown water from Ledbetter Reservoir and pit depressurization water from actively mined pits would be discharged to Lower Haile Gold Mine Creek. The temperature of the drawdown water from Ledbetter Reservoir would likely be similar to ambient conditions in the receiving stream. Post mining, pit lakes would alter water temperatures by facilitating solar warming.

J.6.3.5 Channel Modifications and Diversions

The diverted streams of the North Fork and Haile Gold Mine Creeks could have warmer temperatures relative to ambient temperatures because the pipes would be above ground and exposed to solar warming.

During reclamation, channels would be reconstructed and water temperatures would be similar to those that were present before mining occurred.

J.6.3.6 Overburden Storage Areas

OSAs could cause a reduction in runoff flows due to interception and storage of precipitation on the porous material. This reduction in runoff could affect flows and water temperatures in streams because a lower volume of water moving at a slower velocity has increased exposure to solar radiation. In addition, alteration of the ground cover from a vegetated to a rocky material could cause warming of the runoff relative to the No Action alternative. The sedimentation ponds that treat runoff from OSAs could also cause an increase in water temperatures relative to ambient stream temperatures as described above.

Water temperatures from the runoff of the reclaimed, vegetated area would be similar to the undisturbed conditions. Thus, there would be little impact to receiving stream water temperatures from these sites following reclamation and into the long term.

J.6.3.7 Growth Media Storage Areas

The surface of the growth media storage areas would likely have a warmer temperature relative to the natural, vegetated condition which could cause warming of the runoff relative to the No Action alternative. Sedimentation ponds could also cause an increase in water temperatures relative to ambient stream temperatures as described above.

Water temperatures from the runoff of the reclaimed, vegetated area would be similar to the undisturbed conditions. Thus, there would be little impact to receiving stream water temperatures from these sites following reclamation and into the long term.

J.6.3.8 Johnny’s PAG

Johnny’s PAG could have varying impacts to water temperatures in Lower Haile Gold Mine Creek. The reduction in contributing drainage area (159 acres) would cause decreased flow rates in the creek which could lead to warmer stream temperatures, particularly in the warm summer months when discharges from pit depressurization and the Contact Water Treatment Plant may be low as that discharge water is used for mining operations.

Water temperatures from the runoff of the reclaimed, vegetated area would be similar to the undisturbed conditions. Thus, there would be little impact to receiving stream water temperatures from this site following reclamation and into the long term.

J.6.3.9 Tailings Storage Facility

Construction of the TSF could indirectly impact water temperatures in Lower Camp Branch Creek because flow rates in these segments would be lower during active mining when runoff flows are intercepted at the lined portion of the TSF. This reduction in flow could cause stagnation and warming of waters during low flow, summer conditions.

Water temperatures from the runoff of the reclaimed, vegetated area would be similar to the undisturbed conditions. The effluent from the passive treatment cells would likely be discharged at near ambient conditions although exposure to solar radiation could cause warming of the effluent prior to release. Because the flow rates from the passive treatment cells should be low relative to runoff and baseflows in Camp Branch Creek, there should be little impact to receiving stream water temperatures from this site following reclamation and into the long term.

J.6.3.10 Holly and Hock TSF Borrow Areas

The surface of the borrow areas would likely have a warmer temperature relative to the natural, vegetated condition which could cause warming of the runoff relative to the No Action alternative.

Water temperatures from the runoff of the reclaimed, vegetated area would be similar to the undisturbed conditions. Thus, there would be little impact to receiving stream water temperatures from these sites following reclamation and into the long term.

J.6.3.11 Discharge of Groundwater Depressurization Water

During mining, the groundwater depressurization water would be discharged to Lower Haile Gold Mine Creek. This discharge, which is transported in above ground pipes from above ground storage tanks to the discharge point, could have warmer temperatures relative to ambient temperatures because the pipes would be above ground and exposed to solar warming.

During reclamation, pit depressurization water would no longer be discharged to Haile Gold Mine Creek, so this activity would no longer impact stream temperatures.

J.6.3.12 Ore Processing Facility and Process Ponds

Water use and management at the ore processing facility would impact the amount of depressurization water that is discharged to Haile Gold Mine Creek. Lower usage at the ore processing facility would result in higher discharge rates that would likely raise stream temperatures in the winter months and lower stream temperatures during the summer months. Higher usage at the ore processing facility would result in less discharge to the stream so the thermal impacts would be lower.

Following reclamation, the ore processing facility would be decommissioned, graded, and vegetated. This area would no long impact water temperatures in the receiving streams.

J.6.3.13 Contact Water Treatment Plant

The discharge from the contact water treatment Plant would comply with SCDHEC standards. Because effluent from the plant is piped around the mining activities and discharged to Lower Haile Gold Mine Creek, this discharge could have warmer temperatures relative to ambient temperatures because the pipes would be above ground and exposed to solar warming. It is likely that discharges in the summer months would be slightly cooler than ambient stream temperatures and discharges in winter months would be warmer than ambient stream temperatures.

J.6.4 Changes in Water Quality

The proposed features and activities could also cause changes to water quality, as described below.

J.6.4.1 Proposed Roads

The disturbed area associated with road construction could impact water quality because runoff from dirt or gravel surfaces often has higher pollutant concentrations and runoff volumes (sediment, etc.) relative to grass, brush, or trees. Vehicles using these proposed roads would release air pollutants into the environment as well. The impact of the proposed roads on water quality would likely be minor relative to other Project activities and features because the area disturbed by road construction and the number of vehicles emitting pollutants (up to 44 pieces of motorized mining equipment [Appendix A] would be relatively small.

Following reclamation, many of the roads would be decommissioned, graded, and vegetated. These areas would no long impact water quality in the receiving streams assuming the vegetation and slopes were stable. The roads and traffic that would remain to support long-term land use could continue to cause minor impacts to surface water quality.

J.6.4.2 Runoff Diversion Facilities

Runoff diversions serve to route water away from disturbed areas or PAG material. This mine feature would not cause significant impacts to water quality relative to other features such as discharges from the Contact Water Treatment Plant. These features are intended to protect non-contact water from mixing with contact water and are a preventative measure associated with the mine plan.

Following reclamation, runoff diversion facilities would be decommissioned, graded, and vegetated. These areas would no longer impact water quality in the receiving streams assuming they are properly maintained.

J.6.4.3 Sedimentation Ponds

Sedimentation ponds would release non-contact storm water to streams in the study area. For storm events that are less than the design storm (10-year, 24-hour), water quality released from the storms should meet SCDHEC requirements due to the sedimentation processes that occur prior to release. Sedimentation ponds also would reduce peak flows discharged to the receiving streams which would mitigate erosive forces on the stream banks. For storms exceeding the design storm, water quality and erosive forces would likely not be fully mitigated and sediment-associated pollutant loads in receiving streams could increase. Sediment that accumulates in the sedimentation ponds would be dredged when the pond reaches 50 percent of its design capacity. Dredged material would be stored in OSAs or in the TSF (NPDES General Permit for Stormwater Discharges from Construction Activities, issued October 15, 2012).

Following reclamation, sedimentation ponds would be filled, graded, and vegetated. These areas would no longer impact water quality in the receiving streams assuming they are properly maintained.

J.6.4.4 Erosion and Sediment Control Measures

Erosion and sediment control measures would be used at all disturbed areas within the Project Boundary to reduce the amount of erosion and sediment loading to natural waterways. In addition to the runoff diversion facilities and sedimentation ponds discussed above, these measures could also include stabilization of disturbed areas using vegetation and/or erosion control blankets, outlet protection devices, and dust control activities. Design specifications for these measures are described in the SCDHEC Storm Water Management BMP Handbook (SCDHEC 2005). Concurrent reclamation would occur where possible to minimize the duration of impacts from land disturbance. Following mining, the OSAs, borrow areas, TSF, and several pits would be stabilized and vegetated using similar measures to control erosion and sediment loading.

J.6.4.5 Pit Development

Pit development could impact water quality in several ways. Draining Ledbetter Reservoir in preparation for removal of the existing dam has the potential to negatively affect water quality and sedimentation downstream in Haile Gold Mine Creek. This drawdown water could be used for construction water or dust suppression or be discharged directly to surface waters. Water quality sampling at SW-02, downstream of the reservoir, indicates generally acceptable water quality that meets state standards (with the except of pH, dissolved aluminum, dissolved copper, total iron, total manganese, total zinc, and dissolved zinc). However, there is insufficient information about water quality in the deeper parts of the reservoir and about sediment quality. In regards to water quality, Ledbetter Reservoir has maximum depths of about 10–15 feet, and water is released from a mid-depth culvert (J. Pappas, pers. Comm., December 6, 2013). Water in deeper areas of the reservoir may periodically have low dissolved oxygen levels, which could affect downstream areas of Haile Gold Mine Creek during drawdown. In addition, given the history of past mining in the upper Haile Gold Mine drainage, there is the potential for contaminated sediments (e.g., metals or any other mining contaminants) in the reservoir, which if released during drawdown and dam removal, could move downstream to Haile Gold Mine Creek and the Little Lynches Reservoir.

Additional water quality impacts could be caused by blasting agents used to break up rock material that typically contain ammonium nitrate-fuel oil mixture. Haile Inc. would use an emulsified blasting agent to reduce the release of nitrate into the environment (Dyno Nobel 2008). During mining, dewatering of the pits would decrease stream baseflows in the study area and impact the residence time and re-aeration rates in the streams. This may lower dissolved oxygen concentrations in the surface waters. Increased residence time and changes in stream temperatures resulting from depressurization could also impact nutrient transformations and algal growth and decay, leading to eutrophication and diurnal swings in dissolved oxygen and pH. Alteration of pH could affect chemical equilibrium, toxicological effects, and the solubility of metals. Because the baseflow contribution to the streams could be reduced, stream water quality may be dominated by runoff and washoff from the land surface.

During reclamation, five of the pits would be backfilled using Yellow overburden material which could contain between 0.2 and 1.0 percent pyritic sulfur. Yellow material would be supplemented with lime and only applied below the typical groundwater surface to prevent oxidation of metal sulfides and mobilization of heavy metals. The Yellow Class backfill would be placed in discrete levels not more than 50 feet thick, and the final Lift would be capped with a 5-foot layer of saprolite to limit oxygen transport into the backfilled pit. The addition of lime and construction of a saprolite layer would be performed as part of this concurrent reclamation during normal mining operations. Green Class overburden could be placed in the pits along with or in lieu of Yellow Class overburden but would be the only class of overburden placed above the long-term inundation elevation. The placement would complete backfilling and be designed to allow stormwater flows to run off the pit backfills. Once backfilled to the surface, the pit area would be graded, contoured with growth media, and seeded (Appendix A). Based on modeling conducted by Schafer, AMEC, and ERC (2013), groundwater interacting with backfill material could have higher concentrations of calcium and sulfate concentrations. During reclamation, concentrations of sulfide, iron, and TDS would likely be elevated, but these concentrations would be expected to decline in the long term (Schafer, AMEC, and ERC 2013a). Particle tracking simulations indicate that groundwater would migrate through the backfilled areas towards Ledbetter Reservoir (Newfields and Schafer 2013).

Three pits would be allowed to fill with groundwater, stormwater runoff, and/or diverted streamflows to form pit lakes. Champion and Small pit lakes would not discharge directly to surface waters but they would discharge to the underlying groundwater system that flows toward the Little Lynches River, even during lake filling (Newfields and Schafer 2013). Ledbetter Pit Lake would discharge to Haile Gold Mine Creek once it fills and would also interact with the underlying groundwater system. Water quality in historic pits within the Project boundary generally had low pH and elevated concentrations of sulfate, iron, and aluminum (Schafer, AMEC, ERC 2013a). The three pit lakes remaining after mining could contribute flows with similar water quality to the groundwater system and to Lower Haile Gold Mine Creek. Haile would monitor the pH of the water in the pit lakes and supplement with lime to maintain a neutral pH and minimize dissolution of metals (Haile 2013). Based on the pit lake water quality modeling, outflows from Ledbetter Pit Lake to Lower Haile Gold Mine Creek would likely have elevated concentrations of total dissolved solids during the reclamation period (relative to current water quality in the streams as well as surface water quality standards) with the highest concentrations occurring when the pit lake initially outflows. These concentrations would decline in the long-term period. The pit lakes could also have zinc concentrations that are higher than surface water quality standards (Schafer 2013).

Schafer et al (2014) developed a mass load model to predict potential impacts of the proposed project on water quality in Lower Haile Gold Mine Creek and Little Lynches River downstream of Haile Gold Mine Creek. Simulations were performed for the year of initial outflow (year 13 post closure) as well as years 30 and 75 after closure. Three flow regimes were assessed: median (50th percentile flows), low (5th percentile flows), and very low (1st percentile flows). Table lists those parameters that could exceed an applicable or relevant water quality standard based on these simulations. The numeric standards and the predicted average annual concentrations are provided in parentheses in the table.

The model predicts that both sulfate and manganese could exceed the secondary drinking water standard. Secondary drinking water standards are set by the USEPA to protect the aesthetic uses of water (taste, odor, color, etc.), and these constituents are regulated in South Carolina and are typically incorporated into various State permits. They are enforced in that they are typically treated as "indicator parameters" and could trigger a more rigorous monitoring program. An elevated indicator parameter would not necessarily trigger remediation. The predicted exceedances indicate that monitoring for these parameters would be prudent.

The model also predicts that some primary drinking water standards may be exceeded: cadmium (adjusted for the hardness of the water) standards may be exceeded during each simulated flow regime approximately 75 years after closure. Antimony could exceed the applicable human consumption and primary drinking water standards during all three simulated flow regimes even 30 years after closure. Mercury and thallium could exceed applicable human consumption standards. Note that the existing water quality database indicates that samples of mercury and thallium were less than the minimum reporting limit (MRL). However, the MRL is greater than the human consumption criteria, so it is not possible to determine if concentrations exceed these standards under baseline conditions. Simulated excursions under the baseline and proposed scenarios may be due to conservative modeling assumptions such as background water quality set equal to the minimum detection limit (minimum detection limit is less than minimum reporting limit). Therefore, although the model predicts minor exceedances of these MCLs, the overestimation inherent in the model (described in Section 4.3) is such that it is difficult to predict if the standards will be met or exceeded in the future. However, the model results do indicate that monitoring for these parameters should be conducted, with contingency measures in the event that the standards are violated.

Table J-68 Constituents for Which Water Quality Standards Could Be Exceeded (Predicted Average Annual Concentrations After Equilibrium is Accounted For)

Constituent	Baseline scenario attains the standard? (Predicted Baseline Concentration)	Simulated increase relative to baseline?	Period during which standard is exceeded	Flow conditions for which standard is exceed during the Period of Exceedance (Predicted Concentration for the Proposed Project)	Standard exceeded under Proposed Action (Numeric Standard)
Sulfate	Yes (5 mg/L)	Yes	Year 13	Very low flow (277 mg/L)	Relevant secondary drinking water standard (250 mg/L)*
Antimony	Yes (5 µg/L)	Yes	Year 13 Year 30	Median (6 µg/L) Low (8 µg/L) Very low (9 µg/L) Low (6 µg/L) Very low (6 µg/L)	Applicable human consumption (5.6 µg/L) and primary drinking water standards (6 µg/L)
Cadmium	No (1 µg/L)	No	Year 75	Median (1 µg/L) Low (1 µg/L) Very low (1 µg/L)	Hardness adjusted CMC (0.9 µg/L) and CCC (0.1 µg/L) for Year 75**
Manganese	No (97 µg/L)	Yes	Year 13 Year 30	Median (70 µg/L) Low (130 µg/L) Very low (140 µg/L) Low (140 µg/L) Very low (220 µg/L)	Relevant secondary drinking water standard (50 µg/L)*
Mercury	No (0.2 µg/L)	No	Year 13, 30, and 75	Median, low, and very low (0.2 µg/L for all years and flow conditions)	Applicable human consumption criteria (0.05 µg/L)
Thallium	No (1 µg/L)	Yes	Year 13, 30, and 75	Median, low, and very low (ranges from 1 µg/L to 2 µg/L)	Applicable human consumption criteria (0.24 µg/L to 0.47 µg/L)

*USEPA secondary drinking water standard. **Calculated by Schafer (2014); hardness adjusted standards for baseline simulation are CMC (0.5 µg/L) and CCC (0.1 µg/L)

Champion and Small Pit Lakes would also have elevated TDS, and levels would take longer to decline that Ledbetter, based on the water quality modeling (Schafer, AMEC, ERC 2013a). The modeling also indicates that most metals concentrations in these two pit lakes would remain below minimum reporting limits if pH is maintained at neutral levels except for barium, manganese, nickel, and zinc which are predicted to be present in measurable quantities.

J.6.4.6 Channel Modifications and Diversions

The diversion of the North Fork and Haile Gold Mine Creeks would not likely cause significant impacts to water quality as the water would primarily be routed from one location to another. High discharge velocities could cause scour of the stream channels in the receiving stream. Haile would use energy dissipating structures to mitigate these forces and reduce stream bank erosion and resultant sediment loading in the channels.

During reclamation, channels would be reconstructed and stabilized, and water quality would be similar to that present before mining occurred.

J.6.4.7 Overburden Storage Areas

The overburden material mined in the pits would be classified as potentially acid-generating (PAG) or not potentially acid-generating (non-PAG) overburden, depending on the amount of acid-generating minerals that occur in the rock (percent of pyritic sulfur). Overburden would be tested and classified during ore control sampling. Six OSAs would store Green material containing less than 0.2% pyritic sulfur (Appendix A). Channels to collect stormwater and sediment would be constructed around the footprint of each OSA, and these channels would discharge to sedimentation ponds constructed around the perimeter of each facility. After the sediment settles out, water retained within the ponds would be discharged to an adjacent drainage consistent with Haile's NPDES General Permit for Stormwater Discharges Associated with Industrial Activities (Except Construction) regulated by the SCDHEC, Bureau of Water, Stormwater Permitting Section (i.e., Haile's Industrial General Permit). The sediment would also be managed in accordance these standards.

In general, OSAs could impact the water quality of runoff due to a change in land cover and slope. However, because these Project features would only contain Green material mostly comprised of large rocky material, and sedimentation ponds are designed to treat runoff from these areas, they would not likely significantly impact water quality.

Water quality from the runoff of the reclaimed, vegetated area would be similar to the undisturbed conditions assuming the slopes and vegetation are maintained. Thus, there would be little impact to receiving stream water quality from these sites following reclamation and into the long term.

J.6.4.8 Growth Media Storage Areas

Growth media storage areas would contain topsoil and other material needed for reclamation. Runoff from these areas would likely continue higher sediment loads relative to runoff from the pre-disturbed condition. Collection channels and sedimentation ponds would be used to transport and mitigate stormwater runoff, so impacts to water quality associated with these features would likely not be significant relative to other mining activities.

Water quality from the runoff of the reclaimed, vegetated area would be similar to the undisturbed conditions assuming the slopes and vegetation are maintained. Thus, there would be little impact to receiving stream water quality from these sites following reclamation and into the long term.

J.6.4.9 Johnny's PAG

Johnny's PAG is a high-density polyethylene (HDPE) lined facility designed to contain Red overburden which may contain greater than 1.0 percent of pyritic sulfur. This facility may also receive Yellow overburden that is not used to back fill pits (Appendix A). Any water that comes in contact with the Red and Yellow Class overburden material on Johnny's PAG is managed as "contact water," meaning water that has come in contact with PAG material and cannot be discharged to surface waters without treatment. Collection channels are built within the HDPE-lined facility and surround Johnny's PAG to divert untreated surface runoff and seepage from the PAG to HDPE-lined collection ponds.

Johnny's PAG would be constructed with an 80-mil thick, HDPE geomembrane liner underlain with low-permeability soils in order to contain and route seepage and runoff waters to two collection ponds (the 465 and 469 Collection Ponds) for contact water treatment. This "contact" stormwater runoff and seepage would be used in the Mill or treated at the on-site Contact Water Treatment Plant. Contact water is not released to the environment without treatment under normal operating conditions (Appendix A). The collection ponds are designed to contain 110 percent of the 100-year, 24-hour precipitation event. Failure of these ponds to contain volumes above the design storm could result in discharge to surface water bodies and significant impacts to water quality.

In the long-term period, when the seepage is reduced to a level where passive treatment systems would effectively treat these lower flows, passive treatment systems would be installed. These passive treatment systems would treat the seepage using an anaerobic (without oxygen) treatment cell filled with organic media containing beneficial bacteria followed by an aerobic (with oxygen) polishing treatment cell and discharge to Haile Gold Mine Creek. Design, operation and discharge of the passive systems would be permitted through SCDHEC, Bureau of Water, NPDES Permitting Division. Based on water quality data collected in the study area by Haile (2012a), the passive treatment systems could result in higher concentrations of certain parameters such as selenium, copper, lead, and iron in the receiving streams. The system would be constructed in the lined 465 and 469 Collection Ponds. Due to the passive (no pumping) nature of the system, the maintenance is expected to be minimal. The media in the cells would require replacement every 25 years or so. Maintenance and monitoring of the passive systems would be included in Haile's Post-Mining Monitoring Plan when passive cell designs are approved by SCDHEC's NPDES Permitting Division and Mining Division (Appendix A). Water quality from the runoff of the reclaimed, vegetated area of Johnny's PAG would be similar to the undisturbed conditions assuming the slopes and vegetation are maintained. Thus, there would be little impact to receiving stream water quality from this site following reclamation and into the long term other than the minor discharges from the passive treatment system. Particle tracking simulations indicate that groundwater would migrate under Johnny's PAG towards Ledbetter Reservoir (Newsfields and Schafer 2013).Failure of the containment system at Johnny's PAG could also significantly impact water quality. Haile (2013) has proposed a monitoring and management plan that would identify and correct these types of failures.

J.6.4.10 Tailings Storage Facility

Construction of the TSF could indirectly impact water quality in Lower Camp Branch Creek because flow rates in these segments could be lower particularly during baseflow conditions. This reduction in flow could cause stagnation and warming of waters during low flow, summer conditions which could decrease dissolved oxygen concentrations and stimulate algal growth. The unlined portion of the TSF could also have direct impacts to water quality in both Upper and Lower Camp Branch Creek due to land cover changes. Runoff from these areas would be diverted to sedimentation ponds before release to Upper Camp Branch Creek. The lined portion of the TSF would not directly impact water quality in the study area because runoff and seepage from this area would be routed to the ore processing facility in a closed loop system.

Water quality from the runoff of the reclaimed, vegetated area would be similar to the undisturbed conditions assuming the slopes and vegetation are maintained. Water quality impacts from the passive treatment system installed at the TSF to treat seepage would be similar to those described above for Johnny's PAG and could include elevated concentrations of selenium, copper, lead, and iron in the receiving streams (Haile 2012a). The seepage water treatment plant and the passive treatment cells at the TSF would discharge to Haile Gold Mine Creek upstream of Ledbetter Pit Lake during reclamation (Schafer, AMEC, ERC 2013a). Failure of the containment system at the TSF could also significantly impact water quality. Haile (2013) has proposed a monitoring and management plan that would identify and correct these types of failures.

J.6.4.11 Holly and Hock TSF Borrow Areas

Topographic and land cover changes at the Holly and Hock TSF borrow areas could impact water quality in the Upper and Lower Camp Branch Creeks. Runoff from these areas would like contain higher loads of sediment and sediment-associated pollutants relative to the No Action Alternative.

Water quality from the runoff of the reclaimed, vegetated area would be similar to the undisturbed conditions assuming the slopes and vegetation are maintained. Thus, there would be little impact to receiving stream water quality from this site following reclamation and into the long term.

J.6.4.12 Discharge of Groundwater Depressurization Water

Discharge of groundwater depressurization water to Haile Gold Mine Creek would also impact water quality in this creek as well as the Little Lynches River downstream of Haile Gold Mine Creek. A summary of the groundwater quality data is provided in Appendix I, and a summary of the surface water quality data is provided in Appendix J. Table J- compares the water quality of these two data sets to predict if discharge of pit depressurization water could have a negative impact to surface water quality in Lower Haile Gold Mine Creek and Little Lynches River downstream. Depending on level the groundwater data is pumped from (e.g., bedrock, saprolite, or coastal plain sands) the impacts could be different. For that reason, discharge to streams could affect water quality in more one way during operations. For example, the majority of the dissolved aluminum concentrations in the groundwater dataset are less than 50 µg/l, but some of the wells have concentrations exceeding 80,000 µg/l. The surface water samples range from less than 50 µg/l up to 1,300 µg/l with the majority of samples greater than 100 µg/l. Therefore, depending on the quality of groundwater being pumped and discharged at a specific time, discharge could raise or lower dissolved aluminum concentrations in the receiving streams. The following categories are assigned and designated in the table with an ●:

- **Could Improve Surface Water Quality –** The groundwater quality is generally better than the surface water quality. Discharge of pit depressurization water could improve water quality in streams (e.g., raise pH)
- **Similar Water Quality –** The groundwater quality observed in the study area is similar to that observed at surface water sampling locations. Discharge of pit depressurization water is not likely to impact water quality.
- **Could Degrade Surface Water Quality –** The groundwater quality is generally poorer than the surface water quality, but the groundwater quality has not been observed in violation of water quality standards. Discharge of pit depressurization water could degrade water quality in streams, but will not likely cause impairment of water quality standards (either drinking water or aquatic life).
- **Could Cause Excursions of Water Quality Standards –** The groundwater quality is generally poorer than the surface water quality, and the groundwater quality has been observed in violation

of water quality standards. Discharge of pit depressurization water could degrade water quality in streams and contribute to impairment of water quality standards (drinking water and/or aquatic life).

- **Could Cause Significant Impacts to Surface Water Quality –** The groundwater quality is much poorer than the surface water quality, and groundwater concentrations have been observed at levels that are one to three orders of magnitude higher than that observed in surface waters. Discharge of pit depressurization water could significantly degrade water quality in streams and cause impairment of water quality standards (drinking water and/or aquatic life). Not all parameters that fall in this category exceed water quality standards (e.g., barium).

During reclamation, pit depressurization water would no longer be discharged to Lower Haile Gold Mine Creek, so this activity would no longer impact stream water quality.

J.6.4.13 Ore Processing Facility and Process Ponds

Water use and management at the ore processing facility would impact the amount of depressurization water that is discharged to Haile Gold Mine Creek. When discharge rates are high relative to streamflows, water quality in the streams would be similar to that of the groundwater from which it was pumped (groundwater quality would likely vary as the wells become deeper). When streamflows are high relative to the discharge rate of groundwater, the impacts to water quality in the surface waters would be minimal. The ore processing facility would also release pollutants into the air (see Section 4.16 in the draft EIS). These releases would be regulated by the Title V Operating Permit which would limit the amount of pollutants released to the atmosphere and therefore the amount that would be deposited on the land or water surfaces.

Following reclamation, the ore processing facility would be decommissioned, graded, and vegetated. This area would no long impact water quality in the receiving streams.

J.6.4.14 Contact Water Treatment Plant

The Contact Water Treatment Plant would be comprised of two reaction tanks, two clarifiers, and a multi-media filtration process designed to remove metals from the contact water treated at the plant (Appendix A). The facility would be designed to meet the numeric limits specified in Permit SC0040479 for Outfall 003. Discharge from this facility would likely increase pH in Lower Haile Gold Mine Creek and the downstream reaches of Little Lynches River. Concentrations of total suspended solids, arsenic, cadmium, copper, lead, mercury, thallium, zinc, and selenium could increase in these reaches[3] compared to concentrations observed by Haile, Inc (Haile 2012a). Permitted concentrations for arsenic, cadmium, copper, lead, zinc, and selenium exceed either the drinking water quality standards, the aquatic life standards, or both standards. Residual sludge from the contact water treatment process would be transported and contained in the TSF.

During reclamation, this plant would be reconfigured and re-permitted to treat seepage from the TSF. Once seepage flows from the TSF are low enough to be treated passively, the Contact Water Treatment Plant would be decommissioned, graded, and vegetated. This area would no long impact water quality in the receiving streams.

3 Cyanide is included in the SCDHEC discharge permit No. SC0040479 for the water treatment plant, and discharge limits are provided in the permit, but according to Haile, there is no source of cyanide to the water treatment plant. The water treatment plant treats only contact water, not process water from the Mill or the TSF, and so cyanide should not be present under normal operating conditions.

Table J-69 Quality of the Existing Groundwater Data Relative to the Existing Surface Water Data

Parameter	Could Improve Surface Water Quality	Similar Water Quality	Could Degrade Surface Water Quality	Could Cause Excursions of Water Quality Standards	Could Cause Significant Impacts to Surface Water Quality
pH	●	●			
Dissolved Oxygen			●	●	
Turbidity	●	●	●	●	
Aluminum, dissolved	●	●	●	●	●
Antimony, total		●	●	●	●
Arsenic, total		●	●	●	●
Arsenic, dissolved		●	●	●	●
Barium, total	●	●	●		●
Beryllium, total		●	●	●	●
Cadmium, total		●	●	●	●
Cadmium, dissolved		●	●	●	●
Chromium (III), total		●	●	●	●
Hexavalent chromium (IV)		●	●	●	●
Chromium, total		●	●	●	●
Copper, total		●	●	●	●
Copper, dissolved		●	●	●	●
Fluoride		●			
Iron, total	●	●	●	●	●
Lead, total		●	●	●	●
Lead. Dissolved		●	●	●	●
Manganese, total		●	●	●	●
Mercury, total		●	●		
Mercury, dissolved		●	●		
Nickel, total		●	●	●	●
Nickel, dissolved		●	●	●	
Selenium, total		●	●	●	●
Silver, total		●	●	●	

Parameter	Could Improve Surface Water Quality	Similar Water Quality	Could Degrade Surface Water Quality	Could Cause Excursions of Water Quality Standards	Could Cause Significant Impacts to Surface Water Quality
Thallium, total		●	●	●	
Zinc, total		●	●	●	
Zinc, dissolved		●	●	●	
Cyanide		●			
Total dissolved solids		●	●	●	●
Sulfate		●			
Total suspended solids		●	●		●

J.6.4.15 Spill Containment

Each storage area for chemicals and fuel would be constructed on a concrete slab with concrete walls designed to store 110 percent of the volume of the largest container in the process area as well as the 100-year, 24-hour storm event (if the area is not covered). The floors would slope toward a sump pump, and collected material would be pumped to the appropriate component of the ore extraction process. Each area would be designed to overflow to the 1.5 million gallon, HDPE-lined Process Event Pond. The Process Event Pond would provide a backup measure for the on-site containment of spills in the event that a spill exceeds the storage capacity of the area. Chemicals entering the Process Event Pond would either be used in the ore extraction process as applicable or treated before release to the environment.

During reclamation, this plant would be reconfigured and re-permitted to treat seepage from the TSF. Once seepage flows from the TSF are low enough to be treated passively, the Contact Water Treatment Plant would be decommissioned, graded, and vegetated. This area would no long impact water quality in the receiving streams.

J.6.4.16 Summary of Impacts by Stream Segment

Table J-70 summarizes the impacts for each stream segment in the study area.

Table J-70 Potential Impacts on Water Quality under the Applicant's Proposed Project

Potential Impacts	Segments Affected during Active-Mining Period	Segments Affected during Post-Mining Period
Reductions in stream flows could cause reductions in dissolved oxygen concentrations and increases in eutrophication. Increased eutrophication could alter pH, which could affect chemical equilibrium, toxicological effects, and the solubility of metals.	All segments in the study area.	All segments in the study area.
Changes in land cover could cause increased loads of sediment and sediment-associated pollutants in the basin directly affected and downstream.	All segments in the study area, except the unnamed tributary near Camp Branch Creek and Buffalo Creek.	All disturbed areas would be stabilized and reclaimed after mining.
Fugitive dust and air emissions settling in the drainage area and surface waters could increase pollutant loading.	All segments in the study area.	Impact would not occur post-mining.
Failure of the containment system at the TSF could significantly affect water quality	Upper and Lower Camp Branch Creek. All segments of the Little Lynches River downstream of Camp Branch Creek.	Upper and Lower Camp Branch Creek. All segments of the Little Lynches River downstream of Camp Branch Creek.
Failure of the containment system at the ore processing facility could significantly affect water quality.	All segments of Haile Gold Mine Creek. The Little Lynches River downstream of Haile Gold Mine Creek.	Impact would not occur post-mining.
Failure of the containment system at Johnny's PAG could significantly affect water quality.	Segments of Haile Gold Mine Creek within and downstream of mining. Segments of Little Lynches River downstream of Haile Gold Mine Creek	Segments of Haile Gold Mine Creek within and downstream of mining. Segments of Little Lynches River downstream of Haile Gold Mine Creek.
Streams would be covered by mining features (TSF and OSAs).	Upper Camp Branch Creek Three unnamed tributaries under the Ramona OSA	Upper Camp Branch Creek. Three unnamed tributaries under the Ramona OSA.
Discharges from the water treatment plant could increase loading of total suspended solids, arsenic, cadmium, copper, lead, thallium, mercury, zinc, and selenium in the stream and could increase pH.	Segments of Haile Gold Mine Creek within and downstream of mining. Segments of Little Lynches River downstream of Haile Gold Mine Creek.	Segments of Haile Gold Mine Creek within and downstream of mining. Segments of Little Lynches River downstream of Haile Gold Mine Creek.
Discharges from drawdown of Ledbetter Reservoir and pit depressurization would cause varying impacts on stream water quality, depending on the quality of the discharge.	Segments of Haile Gold Mine Creek within and downstream of mining. Segments of the Little Lynches River downstream of Haile Gold Mine Creek.	Impacts would not occur post mining.
Stream diversion and altered flow regime could affect residence time and reaction kinetics.	Segments of Haile Gold Mine Creek within and downstream of mining.	Impacts would not occur post mining.

Potential Impacts	Segments Affected during Active-Mining Period	Segments Affected during Post-Mining Period
Discharges from passive treatment cells could increase concentrations of parameters such as selenium, copper, lead, and iron.	Upper and lower Camp Branch Creek. Haile Gold Mine Creek within and downstream of mining. All segments of the Little Lynches River downstream of Camp Branch Creek.	Upper and lower Camp Branch Creek. Haile Gold Mine Creek within and downstream of mining. All segments of the Little Lynches River downstream of Camp Branch Creek.
Interaction of groundwater with Champion and Small Pit Lakes could affect water quality in the groundwater that contributes flow to this segment and could increase concentrations of barium, calcium, manganese, nickel, sulfate, and zinc.	Impact would not occur during mining.	Unnamed tributary near western side of Champion Pit. Unnamed tributary near southern side of Champion Pit.
Surface water releases from Ledbetter Pit Lake could cause low pH and elevated concentrations of sulfate, iron, total dissolved solids, aluminum, calcium, antimony, arsenic, copper, lead, manganese, nickel, and thallium.	Impact would not occur during mining.	Segments of Haile Gold Mine Creek within and downstream of mining area. Segments of the Little Lynches River downstream of Haile Gold Mine Creek.
Interaction of groundwater with pit lakes backfilled areas could affect water quality in the groundwater that contributes flow to these segments and could contribute to violations of water quality standards for sulfate, antimony, manganese, and thallium.	Impact would not occur during mining.	Segments of Haile Gold Mine Creek within and downstream of mining area. Segments of the Little Lynches River downstream of Haile Gold Mine Creek.

J.7 Permits Regulating Surface Water Impacts

The USACE and SCDHEC would issue a series of permits before any activities associated with the Proposed or Modified Project could begin. Each of the permits is designed to regulate the mining activities to ensure that State water quality standards are met. When SCDHEC issues NPDES permits, the permit limits may be adjusted to account for factors such as dilution or mixing. The permit rationale document that accompanies the permit explains how permit limits are calculated from water quality standards and other factors. Table J-66 summarizes the permits that would be issued for this project and describes the mining activities and parameters that are addressed by the permit. Additional information regarding these permits and the regulations that govern them is provided in Section 3.4.

Table J-66 Summary of Permits Affecting Water Quality in the Study Area

Applicable Permits and Outfalls	Mining Features and Activities Addressed	Numeric Specifications			General Specifications	
Section 404 Permit USACE 2004-1G-157	…	120.5 acres of direct wetland impact and 26,461linear feet of direct stream impact				
Section 401 Water Quality Certification SCDHEC TBD	…					
NPDES Effluent Disposal Permit SCDHEC SC0040479 - Outfall 002	Existing passive treatment cells for reclamation areas (Chase, Hilltop, and Parker)	Parameter	Concentration		Sampling Frequency	Sample Type
			Monthly Average	Daily Maximum		
		Flow, effluent	---	---	2/month	Instantaneous
		pH	Min: 6.0 su; Max: 8.5 su		2/month	Grab
		TSS	20 mg/L	30 mg/L	2/month	Grab
		Copper (as Cu)	15 µg/L	22 µg/L	2/month	Grab
NPDES Effluent Disposal Permit SCDHEC SC0040479 - Outfall 003 (When SCDHEC issues NPDES permits, the permit limits may be adjusted to account for factors such as dilution or mixing. The permit rationale document that accompanies the permit explains how permit limits are calculated from water quality standards and other factors.)	Discharge to North Fork Haile Gold Mine Creek (i.e., Haile Gold Mine Creek within the Mining Area) from the proposed Contact Water Treatment Plant to treat excess contact water from Johnny's PAG, pits, and the ore processing facility	Parameter	Concentration		Sampling Frequency	Sample Type
			Monthly Average	Daily Maximum		
		Duration of Discharge	---	---	1/month	Calculate
		Flow, effluent	---	---	Daily	Continuous
		pH	Min: 6.0 su; Max: 8.5 su		Daily	Continuous
NPDES Effluent Disposal		Parameter	Concentration		Sampling	Sample Type

Applicable Permits and Outfalls	Mining Features and Activities Addressed	Numeric Specifications			General Specifications	
Permit SCDHEC SC0040479 - Outfall 003 (Continued)			Monthly Average	Daily Maximum	Frequency	
		TSS	20 mg/L	30 mg/L	1/week	24-hour Composite
		Cyanide, total	140 µg/L	204 µg/L	1/week	Grab
		Cyanide, free	5.2 µg/L	22 µg/L	1/week	Grab
		Sulfide (as S)	---	---	1/week	Grab
		Hydrogen Sulfide Un-Ionized (H2S)	2.0 µg/L	4.0 µg/L	1/week	Calculation
		Hardness (as CaCO3)	---	---	1/week	Grab
		Arsenic, total	10.0 µg/L	14.6 µg/L	1/week	24-hour Composite
		Cadmium, total	2.4 µg/L	28.7 µg/L	1/week	24-hour Composite
		Copper, total	94.9 µg/L	160.8 µg/L	1/week	24-hour Composite
		Lead, total	49.9 µg/L	600.0 µg/L	1/week	24-hour Composite
		Thallium, total	0.47 µg/L	0.69 µg/L	1/week	24-hour Composite
		Zinc, total	750 µg/L	1500 µg/L	1/week	24-hour Composite
		Selenium, total	5.0 µg/L	20.0 µg/L	1/week	24-hour Composite
		Mercury, total	51.0 ng/L	74.5 ng/L	1/week	Grab
Wastewater Construction/Operating Permits A new construction permit will be required	Construction of the proposed Contact Water Treatment Plant to treat excess contact water from Johnny's PAG, pits, and the ore processing facility					
General Permit for Stormwater Discharges from Industrial Activity SCDHEC SCR004793 SCDHEC SCG730398 SCDHEC SCG730217	Runoff diversions and sedimentation ponds at OSAs, Johnny's PAG, the TSF, and ore processing facility (following construction)				Operate in accordance with the current Storm Water Pollution Prevention Plan	

<table>
<tr><th>Applicable Permits and Outfalls</th><th>Mining Features and Activities Addressed</th><th>Numeric Specifications</th><th>General Specifications</th></tr>
<tr><td>General Permit for Stormwater Discharges from Construction Activity
SCDHEC SCR10S309</td><td>Construction of the ore processing facility</td><td></td><td></td></tr>
<tr><td>Surface Water Withdrawal Permit
A new Surface Water Withdrawal Permit will be required</td><td>Channel modifications and diversions to fill Ledbetter Reservoir after mining</td><td></td><td></td></tr>
<tr><td>Dam Construction Permit
SCDHEC 29-0007</td><td>Construction the dam for the tailings pond at the TSF</td><td></td><td></td></tr>
<tr><td>Abandonment of a Reservoir Permit
This permit will be required to drawdown the tailings pool during reclamation</td><td>TSF</td><td></td><td></td></tr>
<tr><td>Mining/Operating Permit
SCDHEC 601 regulation of current closure and reclamation activities at the Project Site. Also includes mining activities that were permitted in 1984. Application to modify the 601 permit to allow additional mining is the subject of this EIS.</td><td>Proposed roads, runoff diversions, sedimentation ponds, pit development and depressurization, channel modifications and diversions, OSAs, growth media storage areas, Johnny’s PAG, Duckwood TSF, Holly and Hock TSF borrow areas, ore processing facility and Utility Pond, reclamation activities</td><td>
<table>
<tr><th>Feature</th><th>Acreage</th><th>Depth (ft)</th></tr>
<tr><td>Access and haul roads</td><td>143</td><td>At grade</td></tr>
<tr><td>Sedimentation ponds</td><td>112</td><td>Variable</td></tr>
<tr><td>Ledbetter Pit</td><td>101</td><td>840</td></tr>
<tr><td>Snake Pit</td><td>77</td><td>600</td></tr>
<tr><td>Haile Pit</td><td>40</td><td>380</td></tr>
<tr><td>Mill Zone Pit</td><td>47</td><td>400</td></tr>
<tr><td>Red Hill Pit</td><td>36</td><td>240</td></tr>
<tr><td>Chase Pit</td><td>23</td><td>240</td></tr>
<tr><td>Small Pit</td><td>14</td><td>100</td></tr>
<tr><td>Champion Pit</td><td>24</td><td>240</td></tr>
<tr><td>OSAs, growth media storage areas, Johnny’s PAG</td><td>750</td><td>Above grade</td></tr>
<tr><td>Duckwood TSF</td><td>524</td><td>Above grade</td></tr>
<tr><td>Borrow areas</td><td>174</td><td>40</td></tr>
<tr><td></td><td></td><td></td></tr>
</table>
</td><td></td></tr>
</table>

Applicable Permits and Outfalls	Mining Features and Activities Addressed	Numeric Specifications	General Specifications
Air Quality Permits SCDHEC Construction Permit No. 1460-0070-CA Title V Operating Permit (application must be submitted within 12 months of construction completion)	Proposed roads and truck emissions, pit development and blasting, ore processing facility	Refer to permit	Refer to permit

J.8 Proposed Monitoring for Surface Water Impacts

Haile has submitted a preliminary draft Haile Gold Mine Monitoring and Management Plan (Haile 2013) that describes the activities that would be performed to monitor changes in the watershed. The section below described the various monitoring activities associated with the Proposed Project.

J.8.1 Monitoring Changes in Flows, Water Levels, and Stream Morphometry

Table J-67 summarizes the proposed monitoring activities associated with watershed changes and land disturbance.

Table J-67 Proposed Watershed and Land Disturbance Monitoring Program Protocols during Operations

Mining Feature	Monitoring Activity
Tailing Storage Facility (TSF) - Impoundment	The TSF would be monitored for structural integrity and for possible releases of pollutants into the environment, in accordance with its Dam Safety Construction Permit and/or Mining Permit. In accordance with Haile's Mining Permit, Haile anticipates that surface water and groundwater in the vicinity of the TSF would be monitored in order to detect and respond to a release from the tailing and solution stored within the TSF. Runoff from the TSF embankment would be monitored in accordance with the NPDES Industrial General Stormwater Permit. In accordance with Haile's Mining Permit, Haile anticipates that surface water above and below the TSF would be monitored. This monitoring would serve to detect releases from the tailing and solution stored within the facility.
TSF - Underdrain Collection Pond	In accordance with the TSF Operation, Maintenance and Inspection Manual, Haile would undertake periodic visual monitoring and management actions related to the TSF Underdrain Collection Pond, including the Leakage Collection and Recovery Systems (LCRS) and underdrain collection sump pumps, for purposes of prevention, identification, and appropriate response in the event that leakage should develop through the primary HDPE liner in the TSF Underdrain Collection Pond.

Mining Feature	Monitoring Activity
Overburden Storage Areas (OSAs) and Growth Media Storage Facilities	OSAs would be managed and monitored in accordance with Haile's Overburden Management Plan (Schafer, November 2010) and Mining Permit. Runoff from Green OSAs would be managed in accordance with the NPDES Industrial General Permit. During mining, runoff from the Growth Media Storage Areas would be monitored in accordance with the NPDES Industrial General Permit. Consequently, water coming into contact with the growth media would be released to receiving waters without chemical treatment after suspended solids have been removed in sediment ponds. During mining, runoff from OSAs would be monitored in accordance with the NPDES Industrial General Permit for waste rock and overburden piles. Consequently, water coming into contact with the OSAs would be released to receiving waters without chemical treatment after suspended solids have been removed in sediment ponds.
Johnny's Potentially Acid Generating (PAG) OSA (including 465 and 460 Collection Ponds)	Surface water and groundwater in the vicinity of Johnny's PAG would be monitored for purposes of leak detection in accordance with Haile's Mining Permit. This monitoring would serve to detect any release of the PAG material stored within the facility through the HDPE liner and low permeability soils. Since the 465 and 469 Collection Ponds are a source of contact water pursuant to Haile's NPDES Individual Permit, Haile expects that they would be managed in accordance with either its NPDES Individual Permit or Mining Permit, or both. Haile would comply with the reporting requirements for Johnny's PAG and the 465 and 469 Collection Ponds in Haile's NPDES Individual Permit or Mining Permit, or both.
Contact Water Treatment Plant (including 19 Pond)	The Contact Water Treatment Plant would be monitored in accordance with Haile's NPDES Individual Permit and operational aspects in accordance with Haile's Operations and Maintenance Manual. Water quality at the Contact Water Treatment Plant would be monitored in accordance with Haile's NPDES Individual Permit. Since the 19 Pond is a source of contact water pursuant to Haile's NPDES Individual Permit, Haile expects that it would be managed in accordance with this permit.
Mill Site/ore processing facility (including the Process Event Pond)	The Mill and Process Event Pond would be monitored in accordance with Haile's Mining Permit and operational aspects in accordance with Haile's Operating Plans and Procedures for the Mill, which would describe the standard practices necessary for the safe and environmentally sound operation of the facility, and specific measures needed for compliance with applicable regulatory requirements. Haile's Operating Plans and Procedures for the Mill would be in accordance with the International Cyanide Management Code. Section 2, Groundwater, and Section 3, Surface Water (Haile 2013), provide for up-gradient and down-gradient monitoring of the primary facilities at the Project Site, to determine whether constituent migration from the Mill is occurring, as well as appropriate reporting and response activities.
Pipelines	Tailing slurry and process water pipelines would be monitored in accordance with Haile's Mining Permit. Haile's contact water pipelines from originating sources to the 19 Pond would likely be addressed in Haile's NPDES Individual Permit.
Stormwater Management Facilities (including roadside ditches)	Stormwater management at Haile would be guided by the regulations and standards set by the DHEC and Haile's current coverage under the NPDES Industrial General Permit. Presently, all covered stormwater discharges are being managed in accordance with the requirements of the NPDES Industrial General Permit. For construction activities at the Mill area, Haile would comply with the NPDES Construction General Permit. Following construction, this area would follow the NPDES Industrial General Permit.

Source: Haile 2013.

J.8.2 Monitoring Changes in Flows, Water Levels, and Stream Morphometry

Haile has submitted a preliminary draft Haile Gold Mine Monitoring and Management Plan (Haile 2013) that describes the activities that would be performed to monitor changes in streamflows, water levels, and stream morphometry. Streams would be monitored to assess changes in streamflows and the physical characteristics of the channel (e.g., channel cross sections and sediment size). Pit lakes would be monitored to assess changes in water levels. These activities are described in Table J-68 adapted from the Haile Gold Mine Monitoring and Management Plan (Haile 2013). Monitoring water quality and chemistry is described in Section J.4.

Table J-68 Proposed Surface Water Monitoring Program Activities During Operations

Type of Monitoring	Monitor	Protocol	Timing	Rationale
Geomorphology (Channel shape)	Channel cross sections	Survey stream cross sections at permanent locations	Annual	Change in channel width could be a sign of stream aggradation, degradation, vegetative encroachment and/or bed or bank stability alteration.
	Channel profile	Survey stream profiles over a permanent stream reach	Annual	Change in channel profile could be a sign of sediment aggradation or degradation and provide evidence of channel evolution that could occur in response to flow alteration or land use changes.
	Substrate sediment distribution	Determine size distribution of channel substrate	Annual	Changes in channel sediment size could indicate stream response to flow alteration or land use changes.
Surface Water Flow and Water Level	Stream channels	Measure streamflows and water levels	Hourly or quarterly	Mine operations could result in increases and/or decreases to flow at various locations across the site.
	Pit Lakes (Champion, Snake, and Gault)	Measure water levels	Quarterly	Mine operations would result in eventual pit lake dewatering. Water levels would be monitored.

Source: Haile 2013.

J.8.3 Monitoring Changes in Water Quality

Haile has submitted a preliminary draft Haile Gold Mine Monitoring and Management Plan (Haile 2013) that describes the activities that would be performed to monitor changes in the water quality.

Table J-67 summarizes the monitoring activities that are proposed during mining. Haile also proposes to monitor certain mining activities to guide operations with respect to reducing water quality impacts, these monitoring activities are described in Table J-72.

J.10 Literature Cited

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